Time Series Modelling Version 4.25
User's Manual

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This document is also accessible through the program Help pages.

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What's New?

TSM 4.25

* Bootstrap test of I(0).
* 'RGB' scatter plots, with observation dates colour-coded.
* Improved Monte Carlo output format and EDF handling.

NOTE: further revision of EDF file format!

* New data editing/transformation options.
* Improved sample selection options.
* Consolidates a large number of small modifications and fixes

TSM 4.24

* Improved facilities for running and sharing Ox code. Code files now bundled with exported settings, and viewable from the Help menu.
* EDF files for tabulations of different sample sized can now be merged. p-values are generated by interpolating the tabulations according to actual sample size.

NOTE: EDF file and Ox function formats are changed in 4.24!
Files created with and for previous versions of TSM must be modified.

* External batch processing option for estimation and Monte Carlo runs - allows multi-tasking and avoids tying up the GUI for long jobs.
* Improved plotting controls: legends and boxes.

TSM 4.23

* Plug-in bandwidth selection and pre-whitening for HAC covariance estimation.
* New graphics options, including forecast fan charts, selectable line widths, and 8 selectable line style options for series plotting.

TSM 4.22

* Kiefer-Vogelsang-Bunzel (KVB) inference with inconsistent covariance matrix estimation.

TSM 4.21

* Nonlinear moving average (SPS) model feature, providing close approximations to STOPBREAK and STIMA models.
* Recursive coded equations can include the lagged value as an argument.
* Extended options for coding nonlinear models, including nonlinear ECMs, and nonlinear MAs using the recursion feature.
* Panel to create/edit/view a model description. Text is saved with the model.
* Forecast confidence bands now plotted in system forecasts. System impulse response option.

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TSM 4.20

* Automatic regressor selection by optimizing info. criterion.
* Local Whittle ML long memory estimation.
* Nyblom-Hansen model specification tests.
* Coded (nonlinear) equilibrium relations.
* Supplied EDF option for critical values extended to Ox-coded test statistics.
* Text files can be loaded into the results window for editing.
* "Restart" option, for one-click incorporation of changes to user's Ox code.
* Randomized coded simulation models.

TSM 4.19

* A formula parser enables three new features:
  - Algebraic data transformations.
  - Nonlinear parameter restrictions (replaces existing procedure).
  - Nonlinear equation estimation - complements the existing ability to compile Ox functions into the program. More limited in scope, but much simpler to implement.
* Save and use tabulations of test EDFs. This feature implements size correction and estimation of true test powers in simulation experiments. Can also be used to make bespoke tabulations of non-standard tests.
* "Save Selected" command - write selected variables from data set to new file.
* Harris-McCabe-Leybourne (HML) test for long memory of data/residuals.
* Two assignable toolbar buttons, + other interface improvements.
* Improved implementation of supplied Ox-coded statistics.
* Fourier bootstrap option.
* Nyblom-Hansen model stability tests.

TSM 4.18

Code recompiled under Ox 4.02. Dedicated "Stop" button on toolbar to pause calculations. Data plots can be displayed directly, by clicking the variable list in any dialog, and then the "Chart" button. Excel dates for weekly and daily data are read with the data, and used in the output and plots.

TSM 4.17

Progress indicator for numerical optimizations shows the number of iterations and current criterion value.
Improved code for setting model specifications. Parameter values and settings are now preserved under deletion/restoration of regressors. In systems, equations can be deleted/restored without losing values and settings.
Enhanced Monte Carlo module allows multiple experiments in a single run, Experiments can also be extended with additional replications.
'User-supplied statistic' option allows the Monte Carlo module to have a fully general application. The distribution of any function of the data set, coded by the user in Ox, can be studied by simulation, after using TSM's modelling facilities (or user-supplied code) to generate the data.

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TSM 4.16

In the Windows installation, the program can now be started by simply clicking on a ".tsm" (settings) file in Windows Explorer. These files are identified by the TSM icon, as for the Start Menu shortcuts.
A new File / Import Models... function allows model specifications to be copied from one settings file to another.
The File / Export... command is enhanced to save the data and listings files as part of the ".tsm" file. A single settings file can now record a complete working environment, including data, models, graphs and parameter values, and be opened by a single keystroke on a different installation. When an exported file is opened, the data and listing files are recreated automatically in the Start-in directory.
Additional resampling options – sieve-AR bootstrap.
Scatter plots now show regression lines superimposed.

TSM 4.15

has a redesigned interface. Here are the main changes from Versions 4.14 and earlier.

* The Estimation and Sample dialog has been replaced with a simplified Set Sample dialog. This no longer has a toolbar button, but is accessible as a floating window in all the model specification dialogs.

* Estimator selection buttons and 'System of Equations' checkboxes are now located as appropriate in the redesigned Linear Regression and Dynamic Equation dialogs.

* A Parameter Bounds / Grid-Plotting checkbox is located in each Values dialog. The Minimand option is selectable in Options / Optimization and Run.

* Kernel selection for HAC estimators has been moved from Options / General to a redesigned Options / Tests and Diagnostics dialog.

* The Options / Bootstrap and Simulation dialog is now renamed as Simulation and Resampling, and controls both bootstrap and the new subsampling options.

* The new "Dialog" toolbar button can be used in two ways. By default it re-opens the last dialog closed, excepting dialogs with their own buttons. Hover the mouse over it to see its current assignment. Alternatively, it can be permanently assigned to one of a range of dialogs normally accessible from the menus. Set your choice in Options / General.

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0. Introduction

0.1 TSM Basics

TIME SERIES MODELLING Version 4 is an interactive package for modelling and forecasting time series. It is designed primarily for nonlinear dynamic model estimation, including ARMA and ARFIMA models, conditional variance models (ARCH/GARCH and several variants), regime-switching and smooth transition. It also functions well as a user-friendly, general purpose regression package.

To enhance its power and ease of use, the program has various special features not found in comparable packages. It is strongly recommended to read through this introduction before starting work with TSM. It does not aim to describe all the capabilities of the package. These can best be discovered by browsing the menus in conjunction with the Help pages provided for each. Its purpose is to outline TSM's unique design and operating conventions to first-time users.

****
Working with TSM
****

1. ENTERING DATA

Regression packages often have their own proprietary database formats, and getting data into them from different sources can be troublesome. By contrast, TSM reads either ASCII files or spreadsheet files directly. It works smoothly in conjunction with popular spreadsheet programs such as Microsoft Excel, Lotus 123 and OxMetrics, for preliminary data organization, and for further analysis and graphing of outputs. It can itself merge datasets with different start and finish dates and use and display date information, including daily dates in Excel format. It offers flexible single-observation editing, series transformations, and dummy creation capabilities.

2. MENUS AND DIALOGS.

TSM is operated in Graphical User Interface (GUI) mode by setting the options in a number of dialogs. These can be opened from the menu bar or by shortcut buttons on the tool bar. Some operations can be performed in several different ways. For example, an estimation run can be launched from the menus, from the "Running Man" toolbar button, and also from the "Go" buttons in several dialogs. The action of the toolbar button can vary depending on the dialog currently open.

3. COMPUTING ESTIMATES, TESTS AND FORECASTS

The basic method of operation is as follows:

1) Specify the calculations and settings desired, using the Setup, Model, Values and Options menus.
2) Launch the estimation module using one of the commands on the Actions menu, a dialog button, or a tool bar button.

Both the "Running Man" and the "Calculator" buttons on the tool bar launch closed form (non-iterative) estimations, such as OLS and IV, and associated tests and forecasts. For nonlinear estimation (if enabled) the "Running Man" button launches the optimization algorithm, while the "Calculator" button just performs post-estimation computations (forecasts or tests) using the currently stored parameter values, either obtained on the latest run or entered by the user.

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NOTE: forecasts and tests are not computed by merely specifying them in the Options dialog! Use the menu items in the Actions menu for this purpose. The Calculate button performs all the currently specified calculations and generates the complete estimation output for the current parameter values.

Each run has a unique ID number to identify the outputs associated with it, such as graphics files, spreadsheet files, and settings files.

4. SAVING PROGRAM SETTINGS

TSM has a large number of optional settings that most users will want to change only occasionally. The program automatically saves all current settings in a special file called "settings.tsm". When the program is restarted the working environment, with all selected options, is exactly as it was in the last session. (There is an option to discard model specs. at shut-down, and save only the current options.)
Named settings files (with .tsm extension and 'red TSM' Windows icon) can be saved and re-loaded manually at any time.

5. ORGANIZING YOUR WORK

The File / Settings / Export... command saves a complete image of the current session, including options, model specifications, data, generated series, tables and graphics. 'Exported' .tsm files do not contain local path information and are fully portable between installations. When they are opened, the data file and temporary storage (.tsd) files are recreated. This provides an ideal way to share work with collaborators, move between home/office installations and distribute classroom exercises. Double-clicking on a .tsm file icon in Windows Explorer starts the program and loads the file contents automatically.

6. SIMULATION

Part of the TSM philosophy is that any model that can be estimated by the program can also be simulated, using randomly generated disturbances or bootstrapped (randomly resampled) residuals. The former can be Gaussian, or generated from the distribution specified by the selected likelihood function. This feature can be used for one-off simulations whose output is graphed. Comparing the simulation of the fitted model with the original data can be a useful informal diagnostic tool. However, the main application for the simulation module is to running bootstrap tests and Monte Carlo experiments. A flexible interactive Monte Carlo module is provided.

7. MODELS

A "model" is a complete set of specifications and values to estimate, simulate or forecast an equation or system of equations. Any number of these specifications can be stored and recalled during a session, as well as saved permanently in the settings (.tsm) file. For example, this option allows the user to run an exploratory regression on the fly, while working on a complex multiple-equation model, without losing any settings and values. Just use the Model Manager to store the current settings and values to a named model (optionally including the data set). Load the model to restore them again. The generated series, graphics and (optionally) data set associated with a model are stored in a file with '.tsd' extension and 'blue TSM' Windows icon

Models are also used for running Monte Carlo experiments. Select one model

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to generate the data using the simulation module, and another (or the same) model for estimating, allowing a very flexible approach to misspecification analysis.

8. PROGRAMMING WITH TSM

TSM can be called as a module in your own Ox program. It is easy to write out the commands and options set by TSM dialogs as lines of Ox code. Your program can call the main program functions such as "Run_Estimation" and "Run_Simulation", and perform further operations on the output.

The special scripting language is fully detailed in the programming manual. To see what your current set of (non-default) options looks like in coded form, give the command File / Settings / Display/Save Text... and inspect the listing created. The reverse operation is also possible. Write out a set of coded commands in the TSM launch file, and these options are then set when the GUI program is started. This provides an alternative way to set and maintain your list of favourite program options.

****

Modelling with TSM

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9. TYPES OF MODEL

There are two main model specification dialogs, called respectively Linear Regression and Dynamic Equation. The "regression scatter" and "space shuttle" toolbar buttons give direct access to these. (The latter can be optionally hidden to simplify the interface, if these features are not being used.)

Linear Regression is used to specify linear models for estimation by a closed-form expression (or, at most, a fixed, finite sequence of calculations). These include OLS, 2SLS, SUR and 3SLS.

Although linear regressions can also be specified in the Dynamic Equation dialog, its special role is to set up nonlinear dynamic models. All estimation in this dialog, even of linear models, is done by optimizing a log-likelihood or other criterion function numerically, using the BFGS and/or simulated annealing algorithms. Model choices include Gaussian, Student t and GED continuous distributions, binary logit and probit models, and count data models. All these models can feature conditional variances, and Markov switching or smooth transition nonlinearity.

10. SELECTING VARIABLES

Model specification dialogs include a list of variable names, corresponding to the currently loaded data file. Selecting a variable is a two-step procedure. First select a radio button specifying the variable Type - dependent variable(s), one of several types of explanatory variables, instruments, and so forth. Next, click on the desired name in the list, to highlight it. The list can be scrolled, if it is too long to display complete in the dialog. Note that when one or more variables are selected in a category, the corresponding radio button is highlighted with a lighter-grey panel. To see which variables are currently selected in a particular category, click on the radio button in question. A little practice helps to get variable selection smooth and rapid, and it is a good idea to click on each highlighted button in turn to check the specification is as desired, before launching the estimation run. To deselect a variable, simply click on it again to remove the highlight. There is also a "Clear"

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button to remove all the current selections.
NOTE: to display time plots of one or more variables, highlight them in the list and click the 'Data Graphics' button on the toolbar

11. VARIABLE "TYPES"

Explanatory variables in an equation can be of two, or three, different "Types", with a different radio button assigned to each. In some models "typing" is irrelevant (in which case, just choose Type 1), but it has a number of common uses. In linear regressions, it is used to allow lags to be treated differently. Lags up to a specified order can be included automatically, so that lagged values do not need to be created and stored individually in the database. The number of lags is selected with the scroll bar, for all variables of the given Type. For example, assign non-lagged variables such as dummies to Type 1, and distributed lag regressors to Type 2. To allow easy inclusion of the lagged dependent variable, the dependent variable in a regression can be assigned as a Type 2 regressor with lags specified. The current value is omitted from the regressor set automatically. This also works in system models such as VARs.

In the Dynamic Equation dialog, "typing" regressors in combination with specifying autoregressive and moving average components has a special additional role, allowing an equation to feature "structural dynamics" and/or "error dynamics". See the relevant Help pages and the TSM main document, for details on this.

12. PARAMETER VALUES

A special feature of TSM is the Values dialogs, where values and conditions for model parameters can be set. Among the uses of these dialogs are

* Setting starting values for numerical optimization
* Fixing parameters at chosen values during estimation
* Setting inequality constraints on parameters during estimation
* Setting zero or linear restrictions on parameters, either for constrained estimation, or calculation of Wald tests.

The Values dialogs can be accessed from the menu bar, or by the "Values" button in the relevant model specification dialog.

Parameter values obtained in the latest estimation run can be viewed in the Values dialogs, and will form the starting values for the next run unless edited or cleared. Alternatively, the menu item Evaluate at Current Values (or the "Calculator" button) generates the program outputs at these values, without re-optimizing.

13. CODED FUNCTIONS

General nonlinear models can be estimated by creating coded formulae. The program features a formula parser which can evaluate functions of data and/or parameters typed using standard notations. This feature is used to create functions for estimation and parameter restrictions for testing, as well as data transformations.

Alternatively, TSM can estimate a model programmed by the user in the Ox language, while making use of all the estimation, testing and forecasting features of the package. (This feature is distinct from, though compatible with, calling TSM from within an Ox program.)

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14. SYSTEMS OF EQUATIONS

Setting up a system of equations is greatly simplified by requiring that the right-hand side of every equation has the same specification. In this way, only one specification has to be created and stored. This is the natural approach for an unrestricted VAR, for example. To have the equations different from each other (e.g. with identifying restrictions imposed) the method is to create an inclusive specification of which all the actual equations are special cases, and then "fix" the surplus parameters at zero in the Values dialogs - enter 0 in the value fields, and check the 'Fixed' checkboxes. While editing values, one can switch easily from one equation to another, using the 'Next Equation' button or the choice widget on the tool bar. Parameters fixed at 0 are not reported in the output, although those fixed at non-zero values are listed as such.

Systems of coded nonlinear functions can be estimated in the same way. While their specifications can differ, each has the common set of named parameters assigned to it - "fix" the surplus ones in Values / Equation, so that the search algorithm ignores them.

Simultaneous equation systems can be specified by including variables as both dependent variables and Type 1 regressors. When their presence in both sets is detected by the program, the system is estimated by FIML. It is the user's responsibility to ensure that identifying restrictions are imposed on the equations, in this case.

In vector ARMA and GARCH models specified in the Dynamic Equation dialog, the lags of all the variables are included by default in each equation. For example, a VAR(2) system of three equations has 6 regressors in each equation. Of course, some of these regressors can be suppressed if desired, by fixing their coefficients at 0 in the Values dialogs.

Note that a VAR can be set up in either the Linear Regression dialog or the Dynamic Equation dialog. In the first case it will be estimated in two steps, by SUR (equivalently OLS, if unrestricted). In the second case it will be estimated numerically, by Least Generalized Variance or ML.

15. OUTPUT CONVENTIONS

The outputs from TSM are not always the same as those of other packages. t-ratios and p-values are not reported in those cases where "zero" is not the natural null hypothesis for the parameter (variances for example). The Durbin Watson statistic is not reported by default, since it is often not valid in dynamic regressions. See the Tests and Diagnostics Options dialog to select it. A valid LM statistic or M-statistic for residual autocorrelation, or neglected ARCH, can always be computed if desired, and provides an equivalent test to the DW in those cases where it is valid. Autocorrelation Q statistics for residuals and squared residuals are reported by default, as are standard model selection criteria, although these outputs can be optionally suppressed.

Robust standard errors are reported by default. These will not match the "naive" (conventional) standard error formulae reported by most packages, and note that the latter are often based on incorrect assumptions, although they can always be computed as an option. Heteroscedasticity and autocorrelation consistent (HAC)

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standard errors are also optionally available. Test p-values and confidence intervals can also be computed by the parametric bootstrap, based on resampling model residuals and using the fitted model to simulate data under the null hypothesis.

Asymptotic chi-squared statistics are reported by default for the standard tests of restrictions and mis-specification, although reporting in 'F-statistic' form is a selectable option. (Note that in most time series applications, 'F statistics' are not truly F distributed in finite samples.) Bootstrap p-values can be computed if desired, for improved test performance in small samples. Another approach related to the bootstrap is to tabulate test statistics by simulation and use the EDF tabulations to generate p-values.

0.2 How To ....

For the first-time user who doesn't want to spend too much time with the user's manual, here are some simple step-by-step instructions to get you started.

1. HOW TO LOAD A DATA SET

* Click the "Open File" button on the tool bar. In the file dialog, navigate to the Windows folder containing your file in the usual way, and click on it.
* Several different file formats are supported, but an Excel worksheet is a popular choice. The series should be stored in columns, starting in column 2, with the first row of the spreadsheet containing the variable names.

2. HOW TO PLOT DATA SERIES

* Click with the mouse on the variable list in any open dialog.
* Click the "Chart" button on the toolbar, to display plots of all the highlighted series on the list.
* Clicking the "Chart" button without first clicking a variable list opens the Graphics / Show Data Graphic dialog.

3. HOW TO RUN A SIMPLE REGRESSION.

* Click on the "regression scatter" button to open the Linear Regression dialog.
* In the Select Estimator box choose Ordinary Least Squares (the default).
* Choose the dependent variable from the list, and highlight the name by clicking on it with the mouse. At most one name can be selected at once. Note that the radio button is highlighted to show you have made a selection
* In the "Select Regressors" panel, click on the "Type 1" radio button. Then select the regressors from the list, as for the dependent variable. Any number of names can be selected. The radio button is highlighted.
* Click the check-box for Intercept, and, if appropriate, for Trend.
* To ensure your selection of variables is as you intend, it's a good idea the click alternately on the highlighted radio buttons. Note how your selections on the data list are highlighted in turn.
* Click the "Go" button in the dialog - or the "Running Man" or "Calculator" buttons on the tool bar. All have the same action, in this case.
* The results appear in the window. To view the Actual-Fitted and Residual plots, click the "Twin-Graph" button on the tool bar.
* To use less than the complete sample for estimation, click the "Select Sample" button to open the sample-setting dialog. Use the scroll bars to

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select the first and last observation.

* When you launch an estimation run, open dialogs are closed automatically to show the results window. Click the "Windows" button on the tool bar to restore them to their previous locations on the screen.

4. HOW TO GENERATE QUARTERLY DUMMIES

* Click the "f(X)" button on the tool bar.
* Click the Edit button, then scroll down the choice widget until you find "Make Seasonals".
* A scroll bar to choose the frequency appears. Select "4", and press Go.
* Four dummy variables are added to the data set. Add only three of them to your regression if you have an intercept!

5. HOW TO TAKE LOGARITHMS OF YOUR DATA

* Click the "f(X)" button on the tool bar.
* Click the Transform button, then scroll down the choice widget until you find "Logarithm".
* Highlight all the variables on the list you wish to transform.
* Click Go. The transformed variables are added to the data set, identified with the prefix "Log-" added to the name.
* To give a more convenient name, if desired, select Edit and Rename with the choice widget, and enter the new name in the field provided.

6. HOW TO TEST THE SIGNIFICANCE OF THE REGRESSION

* The following procedure provides a valid time series implementation of the "F test of the Regression" reported routinely by many packages. It tests all exogenous regressors, but automatically excludes the trend, seasonal dummies, and lagged dependent variables from the test set. Thus, the null hypothesis can be a valid univariate representation of the dependent variable.
* In the Linear Regression dialog, check "Wald Test of Constraints".
* Use the button beside the checkbox to open the Constraints dialog, and check the box "Test Joint Significance of Regressors".
* The test is computed by running the regression, or by choosing Actions / Compute Test Statistics / Wald Test of Set Restrictions.

7. HOW TO TEST FOR A UNIT ROOT

* Open the Setup / Compute Summary Statistics dialog.
* Check the "Report I(0)/I(1) Tests" checkbox.
* Choose the variable you want to test and press Go.
* The Augmented Dickey-Fuller test and Phillips-Perron statistics are among the results reported. The order of lags in the ADF test is chosen automatically to optimize the Schwarz model selection criterion over the range up to M = O(T^1/3). The bandwidth settings for the Phillips-Perron test can be changed in Options / General...

8. HOW TO ESTIMATE AN ARMA(p,q) MODEL

* Click the "Space Shuttle" button on the tool bar to open the Dynamic Equation dialog. (If this is not shown, open Options / General, check "Enable Optimization Estimators", and restart TSM.)

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* In the Select Estimator box, choose Least Squares.
* Select your dependent variable from the list.
* Use the scroll bars to select the desired AR and MA orders (p and q).
* Select a Type 2 intercept (this is identified even if you have a unit root). You cannot have both types at once, so deselect the Type 1 intercept first, if necessary.
* Press "Go", or the "Running Man" button.
* If your run has been successful, you should see "Strong Convergence" in the results window.
* If you aren't sure what p and q to choose, you can have the program try each pair in succession up to a chosen maximum. Click Setup / Multiple ARMA Models... and select the maximum values you want to try. Click the Running Man with this dialog open, and see the estimates computed successively in the results window.
* You can choose a preferred specification by comparing the Akaike, Schwarz or Hannan-Quinn selection criteria for each model.
* To estimate an ARIMA(p,1,q) model check the "Impose Unit Root" box.

9. HOW TO FORECAST WITH AN ARMA/ARIMA MODEL

* Having selected your model, choose Options / Forecasting..., and use the scroll bar to select the number of post-sample periods to forecast. Note that you cannot forecast beyond the end of the data set if your model contains exogenous variables.
* Select the options "Ex-ante Multi-Step" and "Analytic".
* Now open the Options / Output and Retrieval dialog, and in the panel Print in Results Window, check the option "Forecasts & MA Coeffs".
* If the model has already been estimated, click the "Calculator" button on the tool bar. This will evaluate the model and forecasts. Otherwise, click "Running Man" to run the estimation and forecast calculation in one step.
* To see the point forecasts and confidence intervals graphically, select Graphics / Ex-Ante Forecasts.
* The forecasts can also be exported to a spreadsheet file. Click File / Listings / Save Forecasts.

10. HOW TO ESTIMATE A SIMPLE VAR MODEL

* Open the Linear Regression dialog and check the box "System of Equations". You are now allowed to select two or more dependent variables.
* In the Select Regressors panel, click on the Type 2 radio button. Make the *same* selections as you made for the dependent variables.
* Use the Lags scroll bar to choose the VAR order.
* Select an intercept, if desired. Any exogenous variables can be added to the model as regressors of Type 1.
* Press "Go", or the "Running Man" or "Calculator" buttons to estimate the model.
* Note that when endogenous variables are entered as Type 2 Regressors, the current values are automatically suppressed, making it easy to specify lagged dependent variables.
* A VAR or VARMA can also be estimated in the Dynamic Equation dialog.

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11. HOW TO ESTIMATE A GARCH MODEL

* Open the Dynamic Equations dialog.
* Specify the 'mean equation' as appropriate. This could be an ARMA, or a regression model, for example.
* In the Select Estimator panel, choose Gaussian ML.
* Click on Conditional Variance Model. The Conditional Variance dialog box opens.
* Select the GAR and GMA orders.
* To see the model in the form usually reported (the 'Bollerslev form') open the Options / ML and Dynamics dialog box and, under "GARCH Settings", uncheck the first two checkboxes. (Note, the model you fit is identical in either case. Only the interpretation of the coefficients is affected by these options.)
* Press the Go or Running Man buttons to estimate.
* Estimation of GARCH models can sometimes be tricky. Poor starting values can cause convergence failure. See Help / Hints and Tips for advice on optimization in case of difficulty.

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1. User Interface

1.1 The Menus

Clicking on most menu items opens a dialog in which program settings can be changed. As many dialogs as desired can be open simultaneously.

* The File menu controls loading and saving of settings, data and results.

* The Setup menu controls basic operations such as choice of sample size, data transformations, and storing and loading models. It contains dialogs to control special estimation routines such as multiple ARMA models and recursions, for preliminary data analyses including summary statistics, nonparametric and log-periodogram regression, and cointegration tests. Monte Carlo experiments are also launched from this menu.

* The Model menu is where model specifications are set up.

* The Values menu is for setting starting values and selecting options for model parameters.

* The Actions menu does things. Some of these menu items open dialogs, but most perform actions directly.

* The Graphics menu is to display graphs. An estimation must be run before the equation graphics options are available.

* The Options menu is to change program settings.

* The Help menu gives access to the complete user's manual (also available in PDF format) and the list of data names and descriptions, if these have been created. It also contains commands to open the Registration dialog and "About" window.

Notes:

1. Close a dialog by clicking the "Close" button ([X]) on the menu bar.

2. Positions on the screen of closed dialogs are remembered, even between sessions. This allows the user to create a personalized work layout on the desktop. Use the Reset Dialogs command to centre all dialog positions.

3. Submenus and menu items are "greyed out" when the command is currently unavailable. For example: a data file must be loaded before any action apart from changing options is possible.

4. Remember that to activate a model option (e.g. Conditional Variances, Regime Switching) it must be selected in the Model / Dynamic Equation dialog. Just setting the required options in the dialog does not do this!

5. Values dialogs will not reflect a change in the model specification until either

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the dialog is refreshed or the Values button pressed in the relevant dialog.

6. If a dialog gets hidden behind others, bring it to the top by reselecting it from the menu bar.

7. Default settings (set with 'New' in File / Settings) are listed in Option / General .

1.2 Status Bar and Tool Bar

The status bar at the bottom of the results window shows the name and path of the currently open data file, the currently selected estimator, and the currently selected sample. The symbol "(B)" also appears if bootstrap inference is selected, and the symbol "(S)" if subsampling inference is selected

The tool bar buttons provide quick access to the most frequently used actions and dialogs.

* "Open Folder" button: shows the File / Data / Open dialog.

* "f(x)" button: opens the Setup / Data Transformation and Editing dialog

* "MM" button: opens the Setup / Model Manager dialog.

* "Regression line" button: opens the Model / Linear Regression dialog.

* "Space Shuttle" button (optional): opens the Model / Dynamic Equation dialog

* "Running Man" button (optional): normally, launches Actions / Run Estimation. Also duplicates the function of the "Go" button in an open dialog.

* "Calculator" button: launches Actions / Evaluate at Current Values. This is equivalent to Actions / Run Estimation in the case of linear regression.

* "Chart" button: Dual action.
  - Displays the plot of the variable(s) selected in the variable list in any dialog (first click the list).
  - Opens the Graphics / Show Data Graphic dialog if no variable list has the focus.

* "Double Chart" button: displays combined chart of actual and fitted values, and residuals. Only available following an estimation run. Optionally, can also show the actual-fitted scatter and residual histogram and kernel density (see Options / Graphics).

* "Dialog 1" and "Dialog 2" buttons: can be assigned by the user to open any dialog lacking a dedicated toolbar button. To assign a button, simply open the Options / General dialog, open the target dialog or command, and press

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the assignment button. see Section 8.8 for details.

* "Windows" button: Toggle action.
  - Restores dialogs in previous positions (duplicating Actions / Restore Dialogs) if dialogs closed,
  - Closes all dialogs (duplicating Actions / Close All Dialogs) if dialogs open.

* "Stop" button: only displayed when an iterative calculation is in progress. Pauses the calculation and opens a choice box, to Abort or Continue.

Notes:

1. The "Space Shuttle" and "Running Man" buttons can be optionally omitted from the button bar (deselect "Enable Optimization Estimators" in Options / General). This option can be used to simplify the interface for classroom use.

2. When TSM is running, two "TSM" icons appear on the Windows task bar. The icon enclosed in a white square represents Ox, running in a minimized console window. Click it to view the window. The icon without the white square represents the GUI "front end" running under the Java Runtime Environment.
   Note: if TSM is started by clicking on a settings file in Windows explorer, the Windows “DOS box” icon appears instead of the first TSM icon.

3. The "Windows" button remembers which dialogs were open between sessions. Pressing it at start-up restores the window configuration existing at a recent close-down. To avoid an excessive clutter of dialogs getting re-opened the configuration is reset if the time lag between sessions exceeds 11 hours.

4. When lengthy computations such as optimizations, recursive estimations, grid plots, and Monte Carlo experiments are running, a "Stop" button appears on the tool bar. Clicking the button opens a choice box, with the choice of aborting the run or continuing.
   Note: there may be some delay before the box opens.

1.3 The Results Window

The text area is editable. Comments and aide-memoires can be typed in and saved with the output.

Text can be highlighted with the mouse (hold down the mouse button and drag the "I-beam" cursor) and then cut or copied to the Windows clipboard. Use the right mouse button to open the context menu. The command File / Save Selected Text allows highlighted text to be written to a named file.

The results for an estimation run are printed with a heading showing the version number of the program, a run ID number incremented before each run, and the date and time. The ID number is used to identify retrieved series, and also listings,

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graphics and settings files optionally generated in the run. This makes it easy to verify which piece of output goes with which run, at the end of a session. The current ID is stored in the file settings.tsm. It is preserved when settings are restored to defaults (File / Settings / New). It is reset to 0 only when settings.tsm is deleted.

The text size can be changed from the default of 12-point in the Options / General dialog. The window can be resized by dragging the corner with the mouse, and also maximized to fill the screen. Dialogs are displayed on top of the window. In maximized display mode, dialogs can conveniently be arranged on the right-hand side of the screen, with the results printed on the left-hand side.

The command File / Load Text File allows the window to be used as a text editor. To save text, highlight it and use the File / Save Selected Text command. The main intended purpose of this feature is to allow a user's code to be conveniently edited "on the fly", without needing to start up OxEdit. The command File / Restart closes and restarts the program in exactly its previous state, including window contents, allowing the amended code to be compiled.

1.4 Dialogs

Dialogs are where most interactions between user and program take place. They contain objects of the following kinds

Buttons:	To initiate actions, including opening/closing other dialogs.
Checkboxes:	To turn program options on and off.
Radio Buttons:	To choose from a set of mutually exclusive options.
Choice Widgets:	To make a choice from a list of mutually exclusive options.
Scrollbars:	To input numerical values, usually integers, e.g. sample size.
Text fields:	To input strings of characters from the keyboard. These may represent names to label the output, or real numerical values.
Lists:	Columns of names, usually of data series, that can be selected and deselected with the mouse.

Notes:

1. In model specification dialogs, the choice of radio button may determine the interpretation of list selections. The correct sequence of actions is:
   * Click the radio button to select the type of variable.
   * Click list items to select/deselect them.

   To avoid unintended choices it is a good practice, before launching an estimation run, to click each radio button in turn, and note which variables are highlighted in the list for each case.

2. Choice widgets are similar in function to radio buttons, convenient for larger numbers of alternatives. The widget shows the current selection in the window. Click the down-arrow to display the list, which can be scrolled if necessary, then click the desired selection.

3. Lists are equipped with vertical scroll bars when there are more items than can be displayed at one time. Drag the bar to bring then into view.

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Horizontal scrolling allows long names to be viewed. On occasion Java can fail to display the scrollbars correctly. If this happens try closing and re-opening the dialog, or just drag on the list to scroll it.

4. In some cases (e.g. selecting the dependent variable) only one list selection is allowed at a time. In others, multiple selections are allowed. Clicking a name has a toggle action, select when unselected, deselect when selected. In some dialogs, double-clicking a list item simultaneously selects the item and launches the appropriate action on it, e.g. displaying a plot.

5. To quickly select a block of adjacent names on a list, use 'drag-select'. In other words: click the first name, then click the last name and drag the mouse briefly with the button held down. The dragging action highlights all the names between the two selected cases. Deselection of a selected block works the same way - click the first highlighted name, then 'drag' the last highlighted name. A simple way to clear all the selections in the list is to first drag-select the whole list, then drag-deselect it.

6. The dialog object most recently clicked on is said to 'have the focus', and is outlined by a broken rectangle. If the variable list of any open dialog has the focus, clicking the "Chart" button on the toolbar displays the plot of the highlighted variable(s).
   Note: The current settings in the Graphics / Show Data Graphic... dialog control what items are plotted.

7. Options may be "greyed-out" (disabled) if they are not compatible with other selected options. For example, GARCH and Markov switching options are not available unless a maximum likelihood estimator is selected. In some cases, a reminder message is displayed if an illegal selection is attempted.

8. Make a selection with a horizontal scrollbar by dragging the slider, or by clicking the arrow buttons at each end, for step-by-step selection. Some scrollbars (e.g. for numbers of Monte Carlo replications) are incremented in jumps (10s, 100s) depending on the range of the selection.

1.5 Entering Formulae

Algebraic formulae can be submitted to the program in three contexts.

A. Data transformation
B. Nonlinear parameter constraints
C. Nonlinear equations for estimation or simulation (including equilibrium relations, nonlinear MA terms and nonlinear ECMs)

Formulae are typed into a text box which is opened by the following commands:

Case A: Setup / Data Transformation and Editing / Edit / Make Formula.
Case B: Model / Constraints / Enter Code (select "Coded Restrictions")
Case C: Model / Coded Function.

TYPING FORMULAE

The general syntax is of the form "name = formula",

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Case A: "name" is a new variable name
Case B: "name" is an existing parameter name.
Case C, "Equation": "name" is optional (must match selected dependent variable(s) in Dynamic Equation dialog).
Case C, "Residuals": Omit "name" and " = " (formula implicit).

A formula can be constructed from the following components depending on the formula type, as indicated.

AC: variables, by name or number (see Notes 1, 5) optionally followed by an integer lag (negative) value or lead (positive) value, enclosed in braces {}.

BC: parameters, by name or number (see Notes 1, 6).

ABC: real numeric constants, containing digits 0-9, optionally including a decimal point (.) and optionally preceded by a minus sign (-).

ABC: the operators + (add), - (subtract), * (multiply), / (divide), ^(raise to a power).

ABC: parentheses (...) enclosing sub-formulae.

ABC: the functions log( ), exp( ), cos( ), sin( ), abs( ), sqrt( ), int( ), sgn( ), pos( ) and neg( ) where the parentheses can contain a variable, parameter, constant or sub-formula.

ABC: The names Pi, pi, PI and pI are reserved, and are replaced by the constant 3.14159..., to machine accuracy.

Notes:

1. The first character of a variable or parameter name MUST be a letter (from the sets a-z, A-Z).

2. The following characters can also appear in variable or parameter names: !#$%&',0123456789:;<>?@_~|

3. Names are case-sensitive! E.g. 'Alpha', 'ALPHA' and 'alpha' are all treated as different names.

4. An alternative to typing a variable name in full is to type x[i] or X[i] where "i" denotes the number of the variable in the data list. When the text field is opened, variable numbers are appended in the appropriate data list , i.e.:
   * In case A, Setup / Data Transformation and Editing
   * In case C, Model / Dynamic Equation.

5. An alternative to typing a parameter name in full is to type a[i] or p[i] or A[i] or P[i] (all forms are equivalent) where "i" is the parameter number. Parameter numbers are shown in the Values / Equation dialog(s).

6. The characters +-*/^.()[]{} must NOT appear in names of variables or parameters. Any other characters, in particular spaces, are ignored. Use

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spaces optionally to improve readability.
WARNING: Variable names generated automatically in Setup / Data Transformation and Editing may contain illegal characters!!
Rename such variables before including in a formula.

7. The * sign to denote multiplication is mandatory. Omitting it will cause a syntax error.

8. Numeric constants can contain the symbols .0123456789
The symbol "." (decimal point) may appear ONLY as part of a numeric constant. An isolated "." is parsed as the number 0.

9. Constants are nonnegative. A leading "-" (minus) in any formula is parsed as a unary operator, and changes the sign of the operand.

10. Definitions of special functions:
sgn(x) = -1 if x < 0, 1 otherwise.
pos(x) = x if x > 0, 0 otherwise.
neg(x) = x if x < 0, 0 otherwise.
int(x) = integer nearest to x.
flr(x) = largest integer not exceeding x.
Indicators:
ips(x) = 1 if x > 0, 0 otherwise.
ing(x) = 1 if x < 0, 0 otherwise.
izo(x) = 1 if x = 0, 0 otherwise.
These functions are not differentiable, so may not be used in parameter constraints. This results in a parsing error.
Also note:
pos(x - y) + y = max(x, y)
neg(x - y) + y = min(x, y)
x - y*flr(x/y) = x mod y (x,y integers)
1 - ips(y - x) = 1 if y <= x, 0 otherwise
etc, etc. Other uses include creating period dummies. If t is an integer,
dummy = neg(pos(Trend - t) - 1) + 1
= 0 up to date t, 1 from date t onwards.

11. Reminder: the following uses are mandatory!
* Parentheses ( ) for function arguments and sub-formulae;
* Square brackets [ ] for parameter/variable numbers;
* Braces { } for lags and leads.

12. If the formula cannot be parsed (e.g. non-matching parentheses, missing operators) an error message is printed and the calculations are terminated. If an operation is illegal (e.g. square root of negative number) the output of the formula will be NaN.

RESERVED NAMES

13. The parameter names U#, u#, and N#, n# are reserved, and are treated differently depending on the function call.
In estimation runs they are assigned the value 0. In simulation runs, and

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data transformations, U# and u# are replaced by a uniform[0,1] random drawing, and N# and n# are replaced by a standard normal random drawing.
This feature is primarily to allow the generation of randomized models for (e.g.) test power evaluation.

14. The variable names E#{-j}, e#{-j}, where j represents a positive integer, are reserved for use in recursive functions. They are replaced by the function value itself lagged j periods. E# without a lag is replaced by 0. In systems of equations, the names E#1{-j}, E#2{-j}, ..., denote the values for each equation.

15 The variable names Z# and z# are reserved for used in nonlinear ECMs, and are replaced by the values of the equilibrium relation. In models with two or more equilibrium relations, use Z#1, Z#2, ..., to denote the values.

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2. File

2.0 File: General Information

This menu gives access to submenus for:

Settings	>>	Save and load ".tsm" files.
Data	>>	Save and load data files, including empirical distributions for test statistics.
Results	>>	Control the saving to a file of output from the results window.
Listings	>>	Save items of output from estimation or simulation runs to spreadsheet files.
Graphics	>>	Save a copy of the most recently displayed graphic.

Load Text File — Allows the results window to be used as a text editor. The contents of the chosen file will be appended to the existing window contents.

Save Selected Text — Allows any part of the text in the results window to be saved to a file. Give this command after highlighting the desired text by dragging with the mouse. The options presented are to append the text to the current results file, and to write to (overwrite) a new (existing) named file.

Restart >> — These options close the program, saving all settings and (optionally) data, and immediately restart it. These are convenient shortcuts for loading user's code. (Windows only!)

Restart/Load User Code
A choicebox gives the options of loading the currently specified user Ox code, and selecting a different code file in the file dialog.

Restart/Load Text Input
A choicebox gives the option of selecting a text file containing a set of TSM text commands, for loading as program settings and/or model specifications.

Restart/Load Text Defaults
Loads default settings which (if different from the programmed defaults) will be set with the File / Settings / Clear All command, and also if the settings file is renewed.

Restart/ Simple Restart
The system is restarted without changing load options.

Quit — Closes the program. The prompts to save specification and data before closing can be optionally switched off; go to Options / General.

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Notes:

1 Selected text can be cut, copied or deleted. After highlighting, click the right mouse button and select from the context menu.

2. The contents of the Windows clipboard can be pasted into the results window at the cursor position. Right-click with the mouse, and select "Paste".

MRU LISTS

3. Commands for loading, saving and exporting settings and data files open a popup menu listing the most recently used (MRU) files. The leading item, 'File Dialog...', opens the operating system's file dialog for selecting other files.

4. If a list is empty, the popup menu is skipped and the file dialog opens directly.

5. The maximum number of files on the MRU lists is an installation option - see Appendix B. The default setting is 5.

6. MRU lists are stored in the settings file. When settings are loaded the current lists are appended to the new ones, as space permits.

RESTART

7. The Restart/Load User Code command causes the file "usercode.ox" to be created if necessary, then edited to contain the line
   #include "[chosen file]".
   The chosen file must have extension '.ox'! If necessary, the executable Ox file tsmod_run.ox is also edited to include and #define USER_CODE ' ' #include "usercode.ox" ' compiler directives.
   Note: Only one code file at a time can be compiled. Any other '#include...' statements are deleted from usercode.ox. Other lines are commented out.

8. The Restart/Load Text Input command causes tsmod_run.ox to be edited to include the directive '#define TEXT_INPUT ' and the statement ' Text_Input(){ #include "[chosen file]" } ', which include the contents of the chosen text file as lines in the Text_Input function. After the restart, these lines are deleted to restore tsmod_run.ox to its previous state.

9. The Restart / Load Text Defaults option edits tsmod_run.ox with permanent effect. To restore the standard default settings, edit the file and comment out the '#define TEXT_DEFAULTS' line. The defaults file can also be modified in a text editor. See the programming manual for information on text commands.

10. If the Restart command is given after editing the user's code, resulting in a compilation error, the program will fail to restart. In this event, check the console window for error messages. TSM can always be restarted using the default shortcut if required. This shortcut uses the unchanged copy of tsmod_run.ox in [TSM-HOME].

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11. Use 'Simple Restart' for option changes that require a restart, such as hiding/showing advanced estimation features.

2.1 File / Settings

Settings files (extension ".tsm") save the current state of the program, including optional program settings, model specifications, and parameter values. If the option to save the specifications was selected when it was saved, loading a settings file recreates the exact state of the program at that time, including operational settings, model specifications and starting values. Otherwise, it restores the operational settings only.

The file settings.tsm in the working directory is automatically loaded at start-up, if it exists. It is saved (with the model specifications and starting values) before each estimation call, and also at shutdown. The current state can be saved at any time in a named settings file, and reloaded subsequently.

The available commands are

Open…	Loads settings from a selected file. Only files with extension ".tsm" can be opened.
Save	Saves settings to the default file, "settings.tsm".
Save As...	Saves settings to a named settings file. The extension ".tsm" is added to the file name if not supplied.
Import Models...	Adds the model specifications stored in a named .tsm file to the current settings. Existing models and options are not changed.
Export...	Exports settings, listings and data to a .tsm file.
Settings as Text >>	
Display/Save Settings...	Writes all the non-default settings as text, in TSM script format, either to the results window or to a file.
Save Current Model...	Writes the non-default specifications for the currently loaded model to a file
Save System Defaults...	Writes the current system settings as text.
Clear	Replace all settings with defaults (see Options / General Information and Defaults for a list.)

Notes:

1. Settings are saved automatically to the default file "settings.tsm" before any estimation run and at closedown. Therefore, there is normally no need to save them manually, except to a different named file to store them for subsequent reloading.

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2. In the Windows installation, TSM can be started by double-clicking on a settings file. This loads the file in question, as if loaded by the "Open..." command. Note that settings are saved to the default "settings.tsm" as usual. Use "Save As..." to update a named file.

IMPORTING MODELS

3. The "Import Models..." command can be used to combine models from different files, and also to copy specifications to other installations without affecting operational settings. The models' .tsd files (which can contain the associated data sets, see Setup / Model Manager) should be located in the Start-in or results directory of the installation, so that they can be read.

4. Models cannot be imported from settings files that have been created with the "Export..." command, nor from files that were created with the option "Save Current Results with Settings" checked in Options / General. In this case, load a settings file and save it without these options, before attempting to import from it. Alternatively, save and load the model specifications in text format, see 8 below.

EXPORTING SETTINGS

5. The "Export..." option allows model specifications to be distributed to other users. This option has the following features:

   * All relevant information is saved in the .tsm file, including the current data set(s), model listings (usually saved in separate .tsd files), and supplied Ox code.

   * All local path information, including MRU lists, is omitted from the file.

   * When the file is loaded, the stored data and listings files are automatically saved in the local "Start-in" directory. In this way, the local installation can exactly reproduce the set-up existing on the machine where the 'export' file was created.

6. To be exported using "Export...", supplied Ox code must be contained in one of the following locations:
   1) The standard file "usercode.ox" located in the Start-in directory;

   2) The file named in a "#include" compiler directive in "usercode.ox". In this case,
      * any executable code in "usercode.ox" itself is ignored.
      * only the first "#include" directive in "usercode.ox" is recognised. Any additional inclusions are ignored.

7. Any text in the results window which is highlighted when the File / Export... command is given is stored in the settings file, and written back to the results window at start-up. This trick allows instructions and notes about the contents of the exported file to be easily conveyed to recipients of the file.

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8. The "Display/Save Settings" command opens a choice box, with the options of printing the text in the results window, and opening the file dialog for saving the text. In the latter case, a ".txt" file extension is recommended. See the programming manual for details of the scripting language.

9. The "Save Current Model" command saves just the loaded model settings to a file. To view these settings in TSM, store the model with the "Automatic Descriptions" option checked, then click the "Model Description" button. The main function of this command is to allow the settings to be imported into another instance of TSM using "File / Restart / Load Text Input".

10. The "Save System Defaults" command saves a file for loading at start-up. This options allows the user to control the state of the program set by the File / Settings / Clear All command, or renewing the settings file. Use the File / Restart command to set up the system to read the designated file.

2.2 File / Data

Data can be read in one of seven formats, and saved in one of five formats. The format is specified by the file extension.

".xls"	Excel Worksheet. The first row of the sheet must contain variable names.
".csv"	Comma delimited text file. Format as for .xls.
".wk1", ".wks"	Lotus 123 worksheet. The first row of the sheet must contain variable names.
".in7"	GiveWin file. See Ox and Givewin documentation for details.
".dht"	GAUSS data file. (Not available for saving.)
".dta"	STATA (Versions 4-6) data file. (Not available for saving.)
".dat"	Ox/Givewin "data with load information" file. See the documentation for details.
".mat", or any other.	ASCII file containing a matrix, with variables in columns and observations in rows. The first line of the file must contain two integers, number of rows followed by number of columns. In this case the variable names assigned are "Var1", "Var2", etc. These can be changed in the Data Transformation and Editing dialog.

The available commands are

Recent	Submenu to select one of the five most recently selected files. Any data currently in memory are over-written.
Open…	Opens the operating system's file dialog, for opening. Any data

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currently in memory are over-written.

Merge… Merges new file with data already loaded. After selecting the file, a dialog is presented to enter the 'row offset'; that is, the relative position in the current file of the first observation of the new file. The offset is:

> zero if start dates match,
> positive if start date of new series is later, or
> negative if start date of new series is earlier.

Close the dialog either by pressing "Return" or clicking the Close symbol on the menu bar.

Save Saves data under the name specified in the last Open or Save As command.

Save As… Opens the operating system's file dialog, for saving. The type of file saved (options are Excel, Lotus123, GiveWin, ASCII with load information, or matrix file), is determined either by the extension or, if no extension is added, by the current selection in Options / Output and Retrieval Options.

Clear Clears the current data set.

Tabulations / Load EDF File

Loads a previously prepared spreadsheet file containing an empirical distribution function. This can be displayed in Setup / Look Up Probability and Setup / Look Up Critical Value, and used by the program to generate test p-values. Files with the correct format are generated by the Monte Carlo module, see Setup / Monte Carlo Experiment.

Tabulations / Merge EDF File

Combines selected file with the resident EDF file. When combining tabulations for different sample sizes, the names and specifications for the two tests must be identical.

Tabulations / Clear EDF Table

Removes table from memory. The table is saved with model listings, ('.tsd' files) so use this command before storing a model to avoid bulky files .

Tabulation / Load Density Plot

Loads a previously saved spreadsheet file containing data for generating density plots in the dialog Graphics / Stored MC Distributions. The file contents are merged with any existing plot data. If a loaded plot has an existing name, the name is augmented with "(1)".

Notes:

1. Excel (.xls) spreadsheet files are (since version 4.12) the default data format for TSM, being a common standard that can handle missing values properly.

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Data can always be read in this format, and exported to a different format for editing in an application other than Microsoft Excel, if desired.

2. Data files may be loaded by the program automatically, as when a settings file or a stored model is loaded. If the file in question is not found on the stored path, other paths known to the program are searched, in the following order: the path to the current settings file; the current data folder; the current results folder; and the start-in folder. Messages are printed to show that this has occurred, or if the file is not found anywhere. This feature makes it possible to transfer a settings file to another system on which the stored paths are inappropriate. However, since the file found might not be the one intended, it is important to check the program messages.

3. If data are saved in .MAT format, the variable names are listed in the results window.

4. Ox cannot read or save a data file containing only zeros! See the caveats on artificial data creation using 'Extend Sample' in Setup / Data Transformation and Editing.

5. When the Clear command is given, all menu items and toolbar buttons that operate on data are disabled. The purpose of this command is to allow new data to be created or entered in the Setup / Data Transformation and Editing dialog.

6. The name of a variable, which for convenience should not exceed about 20 characters, can be extended by a longer description. When preparing the data file (e.g. in Excel) optionally divide the name field by the symbol @. All characters following the @ form the description. Descriptions can be viewed by the command Help / Data Descriptions, and edited in Setup / Data Transformations and Editing, see 'Descriptions'. The divider character can be changed during installation, by editing the file tsmgui4.h and setting the function Get_NameCharacter().

MISSING OBSERVATIONS

7. The input file may have missing observations (e.g. blank cells in an Excel file) and these are replaced in the data matrix by NaN (= Not a Number). If the variable in question is included in a model, the sample period is automatically truncated, as necessary, to exclude NaN observations.

PERIODIC OBSERVATIONS AND DATES

8. If provided, date information (years, quarters, months etc.) is used to label graphs and printouts, and is presented in the Setup / Set Sample dialog for selecting the sample.

9. A data file created with GiveWin will contain the date information. If using Excel or other program to create the data file, the date information can be included in the following way. Create a variable with the name !STARTDATE! This must have entries in the first three positions, as follows:
   1. The year of the first observation

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2. The period (quarter/month/week/weekday/day) of the first observation
3. The frequency: one of
   2 (half-years)
   4 (quarters)
   12 (months)
   52 (weeks)
   260 (weekdays)
   365 (days).

The rest of the column can contain anything, or be blank.
This item is removed after being read, so it will not appear in the variable list. If you now save the data file, it will contain the date information in Ox format - the first column of the file will contain the dates in the format "year - period". This column will be used to create date information next time the file is loaded.

10. If files are merged, the date information of the first-loaded file is used unless the merged file contains a !STARTDATE! column, in which case this information is used to date the combined observations. However, GiveWin date information in the merged file is ignored.

11. The periods must have equal length (e.g. no missing holidays, or leap years, in daily data). Otherwise, the data must be treated as undated. However, ignoring these irregularities may be permissible for labelling graphs.

DATED OBSERVATIONS

12. To set individual daily dates, create the data set in Microsoft Excel. Enter the dates in column A of the file in Excel date format (yyyy-mm-dd). If present, these dates will be used by TSM to label the observations. This is the preferred method of dating weekly and daily data, since the irregularities noted in 11 are taken care of.
    Note: You must use Excel or equivalent software to create the dates. This cannot be done in TSM.

13. If dated files are merged in TSM, the dating information in both files is ignored. Use Excel or equivalent software to perform merging operations before loading.

14. Dating information is used automatically if it is present. To over-ride this behaviour and set periodic dates in the default manner, use the "Set Dates" command in Setup / Date Transformation and Editing (Edit). In this case, the existing date information is deleted.

15. When dated observations are saved in Excel format, column A of the spreadsheet contains the usual Ox default dating information. The column of dates is created as column B, with the heading Date in row 1. The first column is ignored when TSM reloads the file, and can be deleted from the spreadsheet if desired.

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2.3 File / Results

Results and information appear in the program's text window.
The output can be saved to disk files in two ways.

1. Select part or all of the window's contents, using the mouse, and append these lines to a designated file.
2. Have all the output saved automatically to a file, in the background.

Both methods can be used at the same time, if desired.

The available commands are

* Enable Background Saving	Switches on Background Save mode
* Disable Background Saving	Switches off Background Save mode.
* New Results File…	Opens the file selection dialog. Choice can be an existing text file, or a new one.
* Locate Results Folder/File.	Show/change the current path to the folder for results and graphics. Optionally, show/change the results file name.

Notes:

1. Results are always appended to a file. To start a new file, choose a new name, or delete the existing file first.

2. The default results file is "tsmresults.txt", in the working directory. This will be created automatically if it does not exist. There is no default name for selections. You are prompted for a file name if one is not currently specified. If background saving is enabled, the New Results File command designates a new file for background saving. If background saving is disabled, the chosen file will be used for selected text.

3. If the directory for a new results file is different from the current working directory, the working directory is changed accordingly. Listings files and graphics will be saved thereafter to the same location. However, the settings file must always reside in the "Start in" directory, so it can be found at launch.

4. To guard against attempting to append text to an existing binary file, results files must have extension ".txt". This is appended to the chosen name if it is not present.

5. Yet another way to save results is to use the Windows clipboard. Just highlight the desired text in the results window, Copy (right-click for the context menu), and Paste into your favourite text editor.

6. The 'Locate Results Folder/File' command displays a text field containing the current path to the results folder. This can be edited to change the folder. If the new path does not point to an existing folder, the change is ignored. NOTE: if no path is displayed, this means that the results folder is the same as the "Start-in" folder, the default.

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7. Pressing the "Locate Results File" button displays both the path and the name of the current results file. The text can be edited to set a new results file and/or path. This is an alternative to giving the "new Results File..." command to open the file dialog.

8. Either method of changing the results file also changes the results folder to the one containing the file. Graphics are always saved in the current results folder. The 'Start-in' folder is used as the results folder by default, but note that the current path is saved between sessions in "settings.tsm".

2.4 File / Listings

This command saves different types of estimation outputs in tabular form:

* Series: (Actuals, Fitted Values, Residuals, Conditional Variances, Regime Probabilities)
* Correlograms and Q Statistics for Residuals and Squared Residuals
* Solved moving average coefficients
* Forecasts
* Recursive estimation outputs
* Recursive forecasts
* Criterion plots

Notes:

1. Only results for the most recent estimation run can be saved. Be sure to save desired outputs before launching another run.

2. Files are named uniquely with a descriptive title and the run ID number. They are saved to the currently selected results folder.

3. Available file formats are the same as for data, and are selected in When saving in ".MAT" format, the columns headings are listed in the results window.

4. There is an option to save all listings automatically, see Options \ Output and Retrieval.

2.5 File / Graphics

Saves the most recently displayed graphic to a file.

Notes:

1. File types and bitmap dimensions (.PNG files) are selected in Options / Graphics.
2. There is an option to save all graphics automatically as they are displayed; see Options / Graphics.

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3. Setup

3.1 Setup / Set Sample

Select the sample for estimation and other data analysis procedures using the scrollbars. Date information is given if provided with the data. The maximum sample is selected by default.

Notes:

1. The sample is automatically truncated to exclude missing values of any variable in the model specified. Remember that missing values are created by taking lags, leads and differences.

2. The sample count is initialized at the first line of the data file, not the first available (non-missing) observation.

3. The "All Available Observations" button is useful to check for missing observations. The largest sample available for all the variables in the currently specified model is selected. The actual sample used for estimation is in any case restricted to this set.

4. This dialog can also be accessed from within other dialogs controlling functions where a sample must be specified. Five different sample selections can be set concurrently, for different program functions. The sample set depends on where the dialog is opened from. The locations are

Setup / Recursive/Rolling Estimation	Sample 1
Setup / Summary Statistics	Sample 2
Setup / Nonparametric Regression	Sample 3
Setup / Semiparametric Long Memory	Sample 3
Setup / Cointegration Analysis	Sample 4
Model / Linear Regression	Sample 1
Model / Dynamic Equation	Sample 1
Graphics / Show Data Graphic	Sample 5

   The function of the dialog when opened from the menu bar depends on which dialog is currently open. By default, it sets Sample 1.

5. Sample selections 1, 3 and 4 are stored as part of a model, and retrieved by reloading the model. Selections 2 and 5 are saved with general program settings.

6. Click the "Simulate" button if the sample is being set for a simulation run, not for estimation. In this case, the "Available Sample" to be checked corresponds to included regressors only, ignoring the 'dependent' variable to be simulated.
   * The button is highlighted when the option is selected. Cancel it by clicking again, or by closing the dialog.
   * The button is disabled unless the dialog is opened from either the menu bar or one of the Model dialogs.

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3.2 Setup / Data Transformations and Editing

In this dialog, data series can be edited, renamed, deleted, and created through as dummies or by transformations of existing variables. The data can be rearranged, sorted, reversed and and written to new files. The commands are arranged under the two headings, editing and transformation.

* Press either "Edit" or "Transform" buttons to bring up the desired list of choices.

* Use the choice widget to choose the desired operation or transformation. Scroll down to see the full list of options (for details see below).

* To execute an edit command or transformation, either highlight one or more variables in the list and press 'Go', or just double-click a variable.

* To mark a variable, highlight it on the list, and press "Mark". To remove the mark, press "Mark" with no variable highlighted.

* If changes are made, the "Save Modified Data" button is enabled. Use this to open the choice box for for saving, either to the original file or as a new file.

EDIT COMMANDS

Note: commands marked with * do not operate on individual variables. Simply press 'Go' to execute. Any highlights in the variable list are ignored in these cases.

"List/Edit/Compare"

Opens a new dialog with a listing of the highlighted series, with observation numbers/dates.

* Use the 'Mark' button to compare two series. If this command is given for a variable while another is marked, the two series are listed side by side.
* To edit an observation, either double-click it, or highlight and press 'Edit Observation'. The existing value appears highlighted in the Edit field. Type the new value, then press
  - 'Enter' (or the [Enter] key) to save the new value, move the highlight to the next observation, and load this for editing.
  - 'Copy' to save the new value, move the highlight to the next observation, but retain the new value in the Edit field.
  - 'Cancel' to discard the new value.

Press Close, or the [X] button, to close the editing dialog, or,
Press >>>>> or <<<<< to list the next/previous series in the data set.
Notes:

1. Use the copy button to repeatedly copy the same value to successive observations for (e.g.) easy creation of dummies for sub-periods.
2. The marked (right-hand) series cannot be edited.
3. CAUTION: editing cannot be undone.

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"Rename"

After selecting a variable and pressing 'Go', a text field appears for typing the new name. The dialog is frozen until 'OK' or the [Enter] key is pressed to complete the entry. If multiple variables are highlighted, each is presented for renaming in turn.

"Delete"

A confirmation box appears. Press the 'All Selected' button to delete all highlighted variables at once, otherwise each is presented in turn for confirmation.
CAUTION! This command cannot be undone.

"Description"

Allows the optional description(s) of the variable(s) to be created or edited. View these descriptions in Help / Data Descriptions.

"Set Dates" *

Allows the dates of observations to be set or changed. This works exactly like the method for inserting date information into a data file prior to loading; see File / Data. for details. A new column of the data set is created with name !STARTDATE!, and opened for editing. Enter the initial year in the first row, the initial sub-period in the second row, and the sub-period frequency in the third row. Enter 2 for half-years, 4 for quarters, 12 for months, etc.
Notes:

1. The new column is deleted immediately after the new information is processed.
2. The date information is saved with the data in GiveWin or other spreadsheet formats, and also in ".dat" files, although not in matrix (.mat) files.
3. CAUTION! This operation is not reversible. If the observations are already dated, the existing date information will be lost, including individual daily dates.
4. If the period is set to 0, the series is treated as undated. Observations are numbered from 1.

"Save Selected"

Allows a subset of the variables to be saved in a new named file. Highlight any number of variables in the list before giving the command. This opens the file dialog for saving, provide a new name and type for the file. The existing data set is unaffected.

"Make Formula" *

Allows any algebraic function of variables to be computed as a new variable. Pressing Go opens the text entry field. For information on typing formulae, see Section 1.5, 'Entering Formulae'.
TEXT BOX CONTROLS

"Cancel"	Closes the text box, discarding changes. No variable created.
"Delete"	Deletes the currently displayed formula, clears field.
"Next"	Displays the next formula, if it exists.
"New"	Opens a new blank formula where there is no "Next".
"Previous"	displays the previous formula, if it exists.

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"OK" Closes the text box and creates the new variable
[Return] Equivalent to pressing "OK".
Closing the text box with the Windows Close button [x] is equivalent to pressing "Cancel".
Note: To evaluate a recursive formula use E#{-j}, where j is a positive integer, to denote the function value lagged j periods.

"Make Seasonals" *

For frequency N, create N dummy variables with every Nth observation = 1, otherwise 0. Set N = 4 for quarterly data, N = 12 for monthly, etc.

"Move Up", "Move Down"

Use these commands to re-order the variables in the data set. Pressing "Go" repeatedly will move a single highlighted variable up or down as many positions as required. Alternatively, move a block of highlighted variables with a single command, but in this case the highlighting is cleared for all but the last.

"Resize Sample" *

Use this command to create additional space for data to be entered by hand, or created by simulation. Type the desired number of observations into the text box provided.

* If this number is less that the number of observations already existing, the sample is trimmed to the specified length.
CAUTION: Excess observations are deleted, this operation is not reversible.
* If the number is greater than the current length, existing series are extended with NaN values. A new variable "Zeros" is created automatically with the full number of observations, with value 0.

Notes:

1. Use Zeros as the dependent variable when specifying a model for simulation, renamed as required.
2. If the data set is initially empty when this command is given (give the command File / Data / Clear to clear the current set) the new data set receives the associated file name 'newdata.xls'.

"Set Sample Start" *

Trims the number of observations specified from the start of the sample. When lags are created, additional rows are added to hold the "pre-sample" observations with other variables set to NaN. This command can be used to remove these extra rows if desired.
CAUTION: this operation is not reversible.

"Delete Selected Rows"

This command deletes complete rows from the data matrix for which the the selected variable equals the constant entered in the box. The constant value can be .NaN, to delete all rows where the selected variable is missing. E.g., to extract the observations for a particular quarter from a quarterly data set, create seasonal dummies and delete the cases where the dummy for the chosen quarter is 0.
CAUTION: this operation is not reversible. Be careful to save the

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reduced data set under a new name!

"Make Zeros", "Make Intercept", "Make Trend" *

These commands create dummy variables. Intercept has values 1, Trend has values 1,2,3,...,T for a sample of T observations.

Notes:

1. To create an event dummy, first create Zeros, then edit it observation by observation in List/Edit/Compare.
2. Use the built-in intercept and trend dummies for estimation wherever possible.

"Make Normal(0,1)", "Make Student t(df)" *

Uses the built-in random number generator to create series of independent observations with the specified distribution.

"Make PDL"

Creates polynomial distributed lag variates (see main document for details) for highlighted variable(s), with lag length specified by the scroll bar. Five new variables are created, corresponding to terms of order 0 up to 4 in the lag polynomial. Delete any unneeded cases.

"Reverse Data" *

Operates on the whole data set, listing the observations in reverse order.

"Sort Data By" *

Operates on the whole data set, sorting the observations according to the ascending order of the highlighted variable. Don't select more than one - If two or more are selected, only the last choice is effective.

"Undo Sort" *

Reverses the action of the Reverse Data and Sort Data By commands, restoring the data set to its original order.

"Shape" *

Re-assembles, by rows, a data series of length T into c columns of length ceil(T/c), where c > 1 is selectable. In case T is not divisible by c, the columns are padded to equal length with zeros, and then with NaNs to fill the rest of the data matrix.

Uses for Shape include the following:

1 Separate the real and imaginary components of a discrete Fourier transform. Set c = 2.
Note: the jth periodogram point, for j = 1,..., [T/2], is the sum of squares of the jth row elements of these columns.

2. Separate seasonal data into its seasonal components. For example, with quarterly data, set c = 4. If the first observation is from Quarter 1, then the first column created will contain the Quarter 1 observations, the second column the Quarter 2 observations, and so on.

TRANSFORM COMMANDS

* Most commands in this menu can also be executed using the Edit / Make

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Formula command. Here, they can be perfomed with a single click on any number of highlighted variables.

* Created series is/are added to the end of the list, with a self-explanatory prefix or suffix appended to the name(s). Use Edit / Rename to change the automatically created name, if desired. Use Edit / Delete to remove any unwanted series.
* Xt, t = 1,...,T denotes a highlighted variable in the data set.
* Mt, t = 1,...,T denotes the 'marked' variable, if any.
* j represents the scrollbar setting for leads/lags/differences.
* C, d, E represent values entered in the text field.

"Lag"	Xt-j
"Lead"	Xt+j
"Difference"	Xt - Xt-j
"Log-Difference"	log(Xt) - log(Xt-j)
"% Difference"	100.(Xt - Xt-J)/Xt-j
"Fractional Difference"	Sum{i=0,...,t-1}Bi*Xt-i, where Bi = Gamma(i-d)/(Gamma(d).Gamma(i+1))
"Cumulate"	Sum{j=0,...,t-1}Xt-j
"Logarithm"	log(Xt)
"Exponential"	exp(Xt)
"Logistic"	exp(Xt)/(1 + exp(Xt))
"Log-Odds"	log(Xt/(C - Xt)) (C = 1 or 100)
"Square"	Xt^2
"Square Root"	Xt^(1/2)
"Reciprocal"	1/Xt
"Power"	X^E (E an integer), |Xt|^E (otherwise)
"Sine"	sin(Pi*C*Xt)
"Cosine"	cos(Pi*C*Xt)
"Absolute Value"	|Xt|
"Max(X,C) (C#Marked)"	max(Xt, C) (max(Xt, C*Mt))
"Min(X,C) (C#Marked)"	min(Xt, C) (min(Xt, C*Mt))
"Sign"	+1 if Xt >= 0, -1 otherwise
"Add C (C#Marked)"	Xt + C (Xt + C*Mt)
"Subtract C (C#Marked)"	Xt - C (Xt - C*Mt)
"Multiply by C (C#Marked)"	Xt*C (Xt*C*Mt)
"Divide by C (C#Marked)"	Xt/C (Xt/(C*Mt))
"Centre (Mean-Devs)"	Xt - Mean(X)
"Standardize"	(Xt - Mean(X))/SD(X)
"Detrend"	Xt - a - b*t (by regression).
"Fourier Transform"	See 5. below.

Additional Notes:

1. When leads, lags are created, the sample selected for estimation will be truncated accordingly. The excess observations are not discarded, however. The end (start) of the data matrix is extended with missing observations represented by NaN.

2. NaN is returned in the case of illegal values (e.g., negative arguments of log(.) and (.)^(1/2), x < 0 and x > C in log-odds.)

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3. The 'Power' transformation returns the power of the absolute value for noninteger exponents. The square root transformation is an alternative way to take the power of 1/2, but behaves differently, assigning NaN to negative observations.

4. The symbols # and % are used in the new variable names to denote multiplication and division in variable names. The more logical choices '*' and '/' cannot be used in file names.

5. "Fourier Transform" computes the FFT of the selected series. The real and imaginary parts of the transform are vectorized to give a real series of the same length of the original, with cosine and sine terms alternating. The components can be separated again if required, using Edit / Shape.
   Note: The series as generated are of length 2T, and are trimmed to fit the existing data set. To avoid losing these points, first extend the data set using Edit / Re-Size Sample.

3.3 Setup / Model Manager

A "model" is the complete set of specifications, values and results from estimation or simulation of an equation or system of equations. At any time, the program holds in memory the specifications that the user has selected, and either starting values entered, or estimated values following an estimation run. This dialog allows model specifications and results to be stored under identifying titles, and subsequently recalled. Material stored includes parameter estimates with information on restrictions or bounds, estimation and testing options, generated series, forecasts, recursive estimates and criterion plots. The latter series can be used to produce additional plots and test statistics without re-running the estimation. Stored models are also used to set up Monte Carlo experiments.

"Load Model"	Loads the model whose title is highlighted in the list.
"Store Current Model"	Opens a text field for the entry of a model title. To complete the entry and store the model, either press Return or click the "OK" button, otherwise click "Cancel" .
"Model Description"	Opens a text box where details of the highlighted model can be entered by the user for later reference. Click the button again to close the box.
"Move Up"/"Move Down"	Use these buttons to arrange the order of the models in the list.
"Delete a Model"	Opens a confirmation box, and removes the model whose title is currently highlighted in the list if the action is confirmed.
"Clear All Models"	Opens a confirmation box, and removes all models in the list if the action is confirmed.

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1. By default, the model title "Run ###" is displayed in the text box, where ### denotes the current run ID number. The entry can then be edited as desired. If an existing title is first highlighted, this name appears in the text box. If "OK" is pressed without changing it, the current specifications overwrite the ones stored under that title. This option allows a stored model to be modified or updated. Rename a model by loading it, saving it under the new title, and then deleting the original copy.

2. The Store command places the model specifications in a memory buffer, but does not save them to disk. Give the command File / Settings / Save or Save As... to save them permanently in a .tsm file. When a settings file is reloaded, the stored models it contains will be accessible as before.

3. The least squares and IV estimation options have different actions, depending on whether estimation is launched from the Linear Regression dialog, or the Dynamic Equation dialog. In the latter case, estimation is done numerically. To make sure the desired estimator is recorded as part of the stored model, have the appropriate dialog open when the "Store" command is given.

4. There is an option to store the estimated model automatically following a successful estimation run - see Options / General. Note that a maximum of 50 models can be stored. To store additional models, save the settings in a named .tsm file, see File / Save As...

5. In addition to parameter values, results and listings associated with a model are stored in a file with the name of the model and the suffix ".tsd". These files are not intended to be read or manipulated outside TSM. To save results to spreadsheet files, use the commands under File / Listings. However, note that the latter data cannot be read back into the program for purposes such as graphing, or calculating tests.

6. If the Store Current Model command is given following a Monte Carlo experiment, the replications or frequency tables (whichever have been specified) are stored in the ".tsd" file under the given model title.

7. If the "Store Data with Model" box is checked, a copy of the data set is saved in the ".tsd" file. This will be loaded automatically when the model is re-loaded. If this box is not checked, you are prompted to save the current data file if it has been edited, and the file with this name is reloaded with the model - however, there is no protection against it being altered in the interim, in this case.

8. If "Store Results with Model" is checked, the text of the last-run estimation output is stored as a string. When the model is re-loaded, the next tile Actions / Evaluate at Current Values is chosen (or "Calculator" button pressed) causes a choice box appears, presenting the option of re-displaying the results.

9. If the "Save as Generic Model" checkbox is checked, the data file is not

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reloaded with the model, which is the default action. This setting is appropriate for models intended to be adapted to different data sets. For example, such a model may specify inputs for a user-coded estimate or test.

Note: If this option is selected, the "Store Data with Model" and "Store Results with Model" options are disabled.

10. Stored models include the current settings for the Semiparametric Long Memory and Cointegration Analysis dialogs. Different settings for these modules can therefore be stored and recalled in the same way as for the main equation specifications.

LOADING MODELS

11. Loading a model overwrites the current settings. Store these first, if they will be needed subsequently.

12. See 8 above: press the "Evaluate" button to re-display the estimation output, if this has been saved with the model. This saves time if re-evaluating the results would be time-consuming, as when output of bootstrap inference is selected.

13. The data file specified in the model will be reloaded automatically, provided it has not been deleted or moved. It can have been edited, or had series added to it, but any variables that appear in the model must of course be present in the file, otherwise an error occurs. It is the user's responsibility to ensure this, and the safest way is to check the "Store Data with Model" box so that a dedicated copy of the data is saved.

DEFAULTS

14. When program settings are cleared and restored to defaults, a model called "Defaults" is created automatically. It is recommended to set up your preferred options for routine operations, and use Defaults to store these settings. They can then be easily restored, by loading this model.

MODEL DESCRIPTIONS

15. When the descriptions box is open, other dialog functions are disabled. However, the description displayed can be changed by selecting a different model from the list. Use the PgUp and PgDn keys to scan rapidly through the list.

16. If the "Automatic Descriptions" checkbox is checked, non-default model settings are written to the descriptions box automatically when the model is stored. These are coded in the scripting language detailed in the programming manual. This provides a convenient way to check that the model specification is as intended.

Note: If either the Semiparametric Long Memory or the Cointegration Analysis dialogs are open when the Store command is given, the settings written relate to those modules; otherwise, the usual model settings are written.

17. If the "Print Descriptions" checkbox is checked, the model description, if any,

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is written to the results windows when the model is loaded.

DELETING MODELS

18. When a model is deleted, the associated ".tsd" file is deleted from the disk. Also note that these files are overwritten when a new model is stored with the same name.

19. There is an option to remove all the ".tsd" files automatically at shutdown. Their contents, except for Monte Carlo results, can be regenerated by running the command Evaluate at Current Values with appropriate options set.

3.4 Setup / Automatic Model Selection

Two options for estimating a sequence of models automatically are controlled from this dialog. Note that they cannot be run simultaneously.

AUTOMATIC REGRESSOR SELECTION

When this option is selected in the Actions menu, or by pressing the "Run Regressor Selection" button, the program chooses the set of regressors to optimize the chosen model selection criterion, out of the specified regressors in a baseline model. The option is described in detail in 6.4 Actions / Automatic Regressor Selection. Use the checkboxes in this dialog to choose which regressor 'Types' are to be included in the initial set to search over.

For example, select 'focus' variables (to be included in every specification) as Type 1 regressors, and 'nuisance' variables, whose inclusion is optional, as Type 2 regressors. To conduct the search over the latter set only, uncheck the box "Include Type 1 Regressors" and check the box "Include Type 2 Regressors".

Notes.

1. To set the selection criterion (one of Akaike, Schwarz and Hannan-Quinn) open Options / Tests and Diagnostics, and select the radio button under "Model Selection Criterion".
   (This setting is also used for choosing lag lengths in ADF cointegration tests and Saikkonen-Stock-Watson efficient estimation.)

2. Tip: to make the lags of a focus (Type 1) variable optional, set Type 1 lags to 0, and then create the one-period lag in Setup / Data Transformation and Editing. Include this variable as a Type 2 with Lags set to the desired maximum.

3. A confirmation box opens to guard against accidental launches. This reminds you what selection criterion is currently chosen.

MULTIPLE ARMA MODELS

When this option is selected in the Actions menu, or by pressing the "Run Multiple ARMA" button, the program automatically estimates all the ARMA(p,q) or ARFIMA(p,d,q) specifications, for all values of p and q in the indicated ranges.

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* Enter max p, max q and max p+q in the text fields provided. With the default settings (all entries = 2) the program estimates the following cases of (p,q), in the order shown: (0,0), (1,0), (2,0), (0,1), (1,1), (0,2).

* A confirmation box appears to guard against accidental launches.

* See Actions / Estimate Multiple ARMA Models for additional details.

3.5 Setup / Recursive/Rolling Estimation

This dialog sets up the options for recursive estimation. For details on the output produced by this option, see Contents / Actions Menu / Recursive/Rolling Estimation.

* Choose rolling estimation (fixed sample size) or incremental estimation (extending sample size) with the radio buttons.

* Set the initial sample in the usual way as the usual estimation sample. Access the Set Sample dialog either using the button provided, or in Setup / Set Sample, or a model dialog.

* 'Step size' is the number of extra observations added at each step. Set by dragging the scrollbar. Setting this equal to 1 may be excessively slow to execute. If it is set greater than 1, the sequences of estimates are plotted as step functions.

* The terminal observation required will in most cases be the maximum available. This scrollbar allows it to be set smaller. Note that the lower limit is constrained by the initial sample and step size settings.

* The first check box allows the option of saving regression diagnostics and test statistics to be selected. This is on by default.

* The second check box allows saving to a file of all the forecasts for each estimation period.
  NOTE: The forecasts, other than the N-step-ahead, cannot be displayed interactively.

* The 'Go' button duplicates the Actions Recursive/ Rolling estimation button. If this dialog is open, the "Run" button on the toolbar is a third way to launch the run. A confirmation box opens to guard against accidental launches.

* By default the number of forecast steps (N) is fixed, and the N-step forecast is reported for each recursion step. If the second check box is checked, the terminal forecast date is fixed, so that N contracts as the end of the sample advances. This option can be used to compare the forecasts of a particular date from different standpoints.

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3.6 Setup / Compute Summary Statistics

This dialog presents the variable list. Select a variable and press 'Go' to print a table of summary statistics. Alternatively, just double-click the variable.

Optionally, the following tests for integration order (I(0) or I(1) are computed:

* Lo's (1991) R/S test for I(0) against I(d), for d > 0 or d < 0. A bounding p-value (probability of the statistic exceeding the computed value under H0) is given in braces.

* The Kwiatkowski et al. (1992) (KPSS) test of I(0), against I(1). A bounding p-value (probability of the statistic exceeding the computed value under H0) is given in braces.

* The Harris-McCabe-Leybourne (2006) N(0,1) test of short memory (see 8.2 Options / Tests and Diagnostics for additional details.

* Phillips-Perron (1988) test of I(1) against I0). A bounding p-value (probability of the statistic lying below the computed value under H0) is given in braces.

* The augmented Dickey-Fuller test of I(1) against I(0). The number of lags is chosen to optimize the Schwarz information criterion over the range 0 to [T^1/3].

* Robinson's semiparametric estimator of d. See Robinson, Anns. Stat. 22 (1994), 515-539. The statistic corresponds to eq. (4.2) of the paper with lamda_m = 2 pi n^{-0.35} and q = 0.5 .

Notes:

1. Check the 'Detrend?' box to compute the statistics for the series after detrending by OLS.

2. Check the 'Differenced?' box to compute the statistics for the differenced series in addition to the undifferenced series.

3. Choose the order of correlograms of the series and squared series, with associated Q statistics, using the scroll bar. If this is set to 0, no correlograms are computed. Choice of Box-Pierce or Ljung-Box Q test variants is selected in Options / Tests and Diagnostics.

4. Check the "Data Correlations?" box to see the correlation matrix of two or more series. In this case, no other statistics appear and the correlograms scrollbar is "greyed out". If only one series is selected with this option set, no output is produced.

5. Check the "Quantiles" checkbox to report the following quantiles of the data distribution: 0.01, 0.05, 0.1, 0.3, 0.5, 0.07, 0.09, 0.95, 0.99. For small samples the extreme cases are omitted.
   * Note that if detrending is specified, the mean of the distribution is zero by construction.

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6. The "Sample..." button opens a dialog to set the sample period to be analysed (Sample 2). See Setup / Set Sample for details.

7. The test p-values are computed from the published tables and are not available for every ordinate. The values given are upper bounds. Dickey-Fuller's table for the maximum sample size is quoted for the ADF and Phillips-Perron tests, and in this case the probabilities refer to the lower tail.

3.7 Setup / Nonparametric Regression

Opens a dialog to specify a Nadaraya-Watson estimate of the conditional mean, using the Gaussian kernel. Two variables must be selected from the list, the dependent variable y and regressor x. Use the radio buttons to toggle between these choices.

Press "Sample ..." to open the Set Sample dialog and select the sample to be analysed (Sample 3). This sample is shared with the semiparametric long memory estimators, and can be set in either dialog.

By default, the bandwidth used is S.n^{-1/5} where n = sample size and S is the sample standard deviation of the regressor. Use the scroll bar to increase or decrease this setting by factors of 2.

The function is plotted with the y-x scatter optionally superimposed.

3.8 Setup / Semiparametric Long Memory

This dialog computes estimates of the long-range dependence parameter d, using one of three semiparametric methods:

* "Narrow-band" log periodogram regression (Geweke and Porter-Hudak, 1983) The log-periodogram points for j=1,...,M are regressed on -2log(sin(pi.j/T)) where T is sample size, and M/T --> 0.

* "Broad-band" log periodogram regression (Moulines and Soulier, 1999) The log-periodogram points for j=1,...,[T/2] are regressed on -2log(sin(pi.j/T)) and P Fourier terms (cosine functions of pi.j/T) to approximate omitted short-range components, where P --> infinity but P/T --> 0.

* Local Whittle Gaussian maximum likelihood (Kunsch 1987, Robinson 1995) Maximizes the frequency domain Gaussian likelihood as function of d, using the first M periodogram points where M/T --> 0.

The outputs from this option includes point estimate, asymptotic standard error and t-test of significance. The log-periodogram regression methods also return a Hausman-type test for the presence of bias (Davidson and Sibbertsen 2006).

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Notes:

1. To run the estimation, select a variable or variables from the list, and press Go. Multiple selections are permitted, and will be computed in succession. Alternatively, just double-click on a variable in the list.

2. The series may be either differenced, or detrended by regression, prior to computing the periodogram. Choose option with the radio buttons.

3. Press "Sample ..." to select the sample for estimation (Sample 3). This is stored independently of the sample selection for other program functions, but is shared with Nonparametric Regression, and can be set in either dialog. See Setup / Set Sample for details.

4. For the GPH bandwidth and trim options, and MS Fourier terms, the power of T being selected (to nearest integer below) is shown as a guideline. Note that the optimal bandwidth is typically a power of T times a constant factor, that may be small. The weight here is 1.

5. The GPH bandwidth setting is chosen with the scroll bar GPH recommended M = O(T^(1/2)). The minimum MSE setting is known to be M = O(T^(4/5)), but the bias can be large with this choice. Experimentation is recommended to see how sensitive the estimate of d is to the selection.

6. The GPH trimming option also omits the lowest frequencies. See the relevant literature for guidance on this setting. If in doubt, keep at 0.

7. The bandwidth used to compute the GPH bias test (see Davidson and Sibbertsen 2006) should be set to the maximum (T/2) to test the hypothesis of a pure fractional process. Use this setting if in doubt. Setting the bandwidth to CT^beta for 4/5 < beta < 1 yields a test of a more general hypothesis, allowing any short-run dependence that does not induce bias. Note that the test is inconsistent with beta <= 4/5.

8. The choice of MS Fourier order is also a trade-off between bias and efficiency - see MS paper for recommendations, or experiment.

9. The smoothing option, available for both estimators, uses local non-overlapping averages of periodogram points in the regression. If in doubt, keep this setting at 1.

3.9 Setup / Cointegration Analysis

This dialog allows a Johansen-type multivariate cointegration analysis to be carried out on any subset of the data. The available procedures are:

* Testing hypotheses of I(0) and I(1) on the selected variables.

* Lag length selection for the Johansen CIVAR, by Akaike, Schwarz or Hannan-Quinn selection criteria.

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* Johansen maximum eigenvalue and trace tests for cointegrating rank.

* Wald tests of structural exclusion restrictions on the cointegrating vectors, including MINIMAL analysis.

Select the variables to be included and CIVAR options, then select the desired procedure using the radio buttons. To execute the procedure press Go, or the Run or Evaluate buttons on the tool bar.

Notes:

1. Open the Set Sample dialog using the "Sample ..." button to set the desired sample (Sample 4). This selection is independent of those set for other program functions. See Setup / Set Sample for details.

2. The KPSS test of I(0) and P-P test of I(1) are also available in the Actions / Summary Statistics dialog, but here, for convenience, are computed for all the selected variables at once.

3. The p-value inequalities reported are taken from the tables of the eigenvalue and trace tests in Osterwald-Lenum (1992)

4. A check box allows the inclusion/exclusion of drift terms in the CIVAR. If the drift is suppressed, intercepts of the estimated cointegrating vectors can be computed. However, note that standard errors are not computed for these.

5. MINIMAL analysis is described in Davidson (1998a). A sequence of chi-squared tests is computed to estimate the set of 'irreducible' cointegrating relations (such that cointegration is not a property of any subset of the included variables.) Identified, structural cointegrating relations must belong to this set. If the cointegration hypothesis is not rejected, estimates of the vectors are reported, with asymptotically valid standard errors, and Phillips-Perron statistics for the corresponding 'cointegrating residuals'.

6. There is the option to specify a single test of the hypothesis that the cointegrating space contains an element subject to specified zero restrictions. When the radio button for this option is selected, the variable list shows only the currently selected CIVAR variables. Select a subset of these to test the hypothesis that they form a "cointegrating subset".

7. Scroll bars allow the setting of lag length, and also the cointegrating rank to be assumed for computing the 'beta' matrix of cointegrating vectors. This setting is taken as given in the MINIMAL analysis.

8. See Davidson (1998a) for details of the "rule of thumb" adjustment to the chi-squared critical values.

3.10 Setup / Monte Carlo Experiments...

This dialog provides the options to set up and run one or more simulation experiments. To make use of it, there should normally be at least one model

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stored using the Setup / Model Manager dialog. If two different models are stored, one can be used to generate the artificial data and the other to specify the estimation, allowing a flexible approach to misspecification analysis.

* Select one or more Data Generation Models (DGMs) from the list

* Select one or more Models for Estimation (EMs) from the list (can be the same as or different from the DGMs).

* Use the scroll bar to select the number of replications, and set other options with the checkboxes.

* Press "Run" to perform the experiment(s). To interrupt a run in progress, press the "Stop" button on the toolbar, with the options of aborting or continuing.

* Press "Results" to re-display the tables from the experiment last run with the currently loaded model.

Notes:

1. Multiple experiments can be set up by selecting two or more models in either category.
   - If one EM is selected and two or more DGMs, then the experiment is performed on the EM using each DGM in turn.
   - If two or more EMs are selected and one DGM, then the experiment is performed on each EM using the specified DGM.
   - If multiple models are selected in both categories, then all the possible experiments are performed - each DGM with each EM in turn.
   - The same model(s) can be selected in both categories.

2. In a single experiment, pressing "Run" a second or further time results in additional replications (the number currently selected) being added to the current set. To start a new experiment, change any model selection, or any option other than number of replications.
   This feature is not available when multiple experiments are specified.

3. The sample period for estimation is always defined by the DGM. The sample settings for the EM are ignored. To have a dynamic simulation run for a number of start-up periods, select the "Presample Data Random in Simulations" option in Options / Simulation and Resampling. Then set the DGM sample period as desired for estimation.

4. If no models are defined, the current specifications are stored as a model with the default name (run ID) and used for both DGM and EM.

5. The DGM specification MUST include a choice of shock distribution (Gaussian, Model or Bootstrap) selected in the Options / Simulation and Resampling dialog. Set the shock variance in the same dialog for the Gaussian option, and appropriate parameter values in the Values dialogs for the Model option. Make these selections before saving the DGM.

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6. Between 1 and 1 million replications can be specified. The selectable values are in the ranges 1,2,..,5,10,...,50, 100,...,1000, 1500,...,10000, 15000,..., 100000, 150000,...1000000.

7. If a test takes a variable parameter, such as degrees of freedom or number of tested restrictions, the tables display this value enclosed in square brackets appended to the test name. The suffix is omitted if the parameter has a default value, such as 1 in the case of t-ratios.

OPTIONS:

8. The parameter moments reported are the mean, standard deviation, skewness and kurtosis of the Monte Carlo distribution of parameter estimates.

9. Optionally, moments can be computed for the estimated standard errors of the estimates, using whatever formula is specified in the estimation model (standard, robust or HAC). The mean of this distribution may, for example, be compared with the SD of the Monte Carlo distribution of the estimate.

10. Parameter biases and RMSE can be reported in cases where the DGM and the estimated model have comparable specifications. If the models are not comparable (having different sets of parameter names) this option is cancelled automatically. However, provided the parameter sets match, the models can otherwise be different. In particular, parameters can be 'fixed' in the estimated model to values different from the DGM, such as 0. This option allows the analysis of omitted variable bias, for example.

11. Any optional tests that are specified in the estimation model will be included in the tabulations. The routinely computed diagnostic tests (Jarque-Bera test and Q tests) can be optionally included in the tabulations. By default, they are omitted.

12. The upper-tail quantiles of the distributions of the test statistics (50%, 10%, 5%, 2.5%, 1%) are optionally reported in the case of parameter t values. By default, the absolute t values are tabulated, so that, for example, the 5% tail quantile should be approximately 1.96 in large samples when the null hypothesis is true.

13. Also optionally reported are the empirical distribution function (EDF) points for the nominal p-values. If the test criteria are correctly sized, these distributions should be Uniform [0,1] if the null hypothesis is true, and 100x% of replications should lie below x. Over-rejection yields a value larger than the nominal one. The cases tabulated are x = 0.01, 0.025, 0.05, 0.1, 0.5.

14. Optionally, the signed t statistics can be tabulated instead of the absolute t statistics, to allow the evaluation of one-tailed tests. In this case, the 5% tail quantiles should be approximately 1.64 in large samples when the null hypothesis is true. Note that the upper tail is tabulated, so be sure the parameters are signed appropriately.

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15. When the models match, the t statistics can optionally be centred on the 'true' parameter values specified by the DGM. With this option selected, the distributions of the test statistics can be studied under the (true) null hypotheses that the parameters takes their DGM values. This option is available only in those cases where the bias and RMSE are available.

16. When the distribution of test statistics follows the distribution specified for the null hypothesis, the p-values should be uniformly distributed, so that their c.d.f is the 45-degree line of the unit square. The Kolmogorov-Smirnov statistic (the maximum absolute difference between the p-value EDF and the uniform distribution) can optionally be calculated. This provides an alternative to the quantiles to assess how closely the distributions match.
Nominal critical values for the K-S distribution, assuming 80+ bins, are 1.22 (10%), 1.35 (5%), 1.63 (1%).
Note: this option is only available if the frequency table is enabled, see 19 below.)

17. If GMM is simulated, there are two options available, the "one-step" estimator, and the efficient GMM estimator using the first-round estimates to compute the weight matrix. Check the "iterated GMM" checkbox to select the latter option. Further iterations are not possible, in this release.

18. Check the box to do a simulation on log periodogram regression. In this case, choose the desired options and variable for study in the Setup / Log Periodogram Regression dialog before storing the model for estimation. The other settings are of course ignored in this case. Note that the DGM may either specify a long memory model, or another model (e.g. a switching model) for an investigation of 'spurious long memory'.

    Note: Although the DGM may feature a 'true' d (ARFIMA) parameter, the bias/RMSE option cannot be selected since the models assumed are not comparable. The bias and RMSE can of course be hand-computed from the information reported.

19. By default, the individual replications are stored. These can be plotted as kernel densities or histograms (see Graphics menu) , or written out to a spreadsheet file for further analysis using Files / Listings / Save MonteCarlo Replications. However, when very large simulations are run this option may put pressure on available memory. Checking the option Save Frequency Table results in the frequencies being accumulated during the run. The actual replications are discarded, so there is no memory constraint. A different routine is used to generate the frequency plots in this case.

20. Increasing the number of bins used to generate the frequency distributions gives more accurate estimates of quantiles and test sizes, at the cost of greater computing time. The default setting of 100 gives sizes estimated to the nearest percentage point.

21. Check the "Save EDFs" checkbox to save tabulations of the empirical

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distribution of test statistics. If the t statistics are centred on the true parameter values, or otherwise if the null hypothesis of interest is set to be true in the simulation, these distributions can be used to provide critical values, and hence to estimate true test powers by simulating cases of the alternative. These tables can also be used to generate p-values for tests in observed data.

22. EDFs are saved as spreadsheet or matrix files of the type specified by Options / Output and Retrieval / "Export Listings to Files of Type". The assigned file names are of the form "EDF_Run" + run i.d. + extension. These files can be renamed, merged and/or edited either in TSM or a spreadsheet program (see below). See Appendix G for details of the EDF file format.

RUNNING AN EXTERNAL PROCESS

23. Check the "Run as External Process" checkbox to launch the run as a batch job in a console window. The calculations are a run in a new instance of Ox, running in a console window. A temporary executable Ox file is created to be run in batch mode.

24. This option allows the TSM GUI to remain under the user's control for other tasks while a long Monte Carlo job is performed. It also allows two or more jobs to run be concurrently. Since Ox is not multi-threaded, this is the best way to make full use of a multi-core processor.

25. When the run is completed the results are sent to a text file that can be loaded in the TSM window using the command File / Load Text File. The temporary ".ox" file created to run the job is deleted at closedown if "Delete Temporary Files on Exit" is checked in Options / General.

26. If the checkbox "Defer External Jobs" is checked in Options / General, the Ox file containing the job is created, but not run. Use this option if the job is to be run on a different machine, for example.

ADDITIONAL OPTIONS

27. The results of the experiment, including tables and plots data, are automatically stored, with the Data Generation model, at the end of the run. Reloading this model allows the tables (using the "Results" command) and graphics to be re-displayed at any time. When performing a sequence of experiments, save the Data Generation model under a new name before modifying it, so as to preserve these results for future study.

28. The complete set of replications (or the frequency table if this option is selected) can be also exported to a spreadsheet file for further analysis. Give the command File / Listings / Save Monte Carlo Replications. The distributions can also by displayed graphically. The command Graphics / Monte Carlo Distributions opens a dialog to select and display the empirical densities of each parameter, test statistic and p-value. These are optionally displayed in both histogram and kernel density form. The normal curve with matching mean and variance can be optionally superimposed for comparison; see Options / Graphics.

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29. See 7.3 Graphics / Monte Carlo Graphics for further information about creating plots, including the ability to combine density plots from different experiments, for comparison.

3.11 Setup / Tail Probabilities and Critical Values...

This dialog gives access to tabulations and plots of standard distributions: the standard normal and Student t, either signed or absolute, and the chi-squared and F distributions.

* Select the radio button for the distribution required.

* Set degrees of freedom as appropriate (except for "EDF from File", see Note 4 below).

* Depending on the dialog opened, enter either the critical value to get the tail probability, or the tail probability to get the critical value.

* To show the probability/critical value (also printed in the results window) press the right-hand button. To plot the density with the tail area shaded, press the left-hand button.

Notes:

1. The "tail probability" is the area of the upper tail of the density, to the right of the critical value. Use the critical value to perform a 1-tailed test with the corresponding significance level.

2. The distributions "|Normal|" and "|Student t|" allow calculation of p-values for 2-tailed tests. These correspond to the p-values reported with the estimation output.

3. Use the signed distributions "Normal" and "Student t" to calculate p-values for 1-tailed tests. Just cut and paste the test statistic into the "Look Up Tail Probability" dialog. Change its sign for tests of the lower tail.

4. Select "EDF from File", then press "Select", to choose a test statistic from the currently open EDF file - the file dialog opens automatically if no EDF file is currently open. To open a different EDF file, use the command File / Data / Load EDF.

5. The density plot is the same in either dialog. The shaded region is the area corresponding to the tail probability, and equivalently, the area to the right of the critical value.

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4. Model

4.0 Model / General

The special model features specified in these dialogs (conditional variance, supplied function, regime switching, equilibrium relations, parameter constraints) are turned "on" and "off" by checking/unchecking the relevant boxes in the main "Dynamic Equation..." dialog. The current settings are retained even when the feature is deselected, and can be re-activated by checking it again. The current selection is shown by check marks against the menu items, as well as by the check boxes.

All dialogs are closed before an estimation is run. Restore them to their original positions by the Actions / Restore Dialogs command, or by clicking the Windows button on the tool bar. Alternatively, select the option to have them restored automatically; see Options / General.

BUTTONS

1. The "Values" button either opens the corresponding Values dialog, or refreshes it with new settings if it is already open. If any parameters are "fixed" in this dialog, the button is highlighted as a reminder.

2. The "Clear" button sets all specifications in the dialog to the defaults.

3. The "Go" button, where provided, is an alternative way to launch an estimation, equivalent to selecting the "Run" button on the toolbar, or the Actions / Run Estimation menu item.

4. Where provided, the "Sample" button opens the Setup / Set Sample dialog.

5. Where provided, the "Options" button opens the last-opened estimation options dialog from the Options menu. By default, this is the Tests and Diagnostics dialog.
   Notes:
   1) Pressing the Options button repeatedly cycles through all the accessible options dialogs.
   2) Only relevant options are accessible from this button, depending on whether it is located in the Linear Regression or Dynamic Equation dialog. All options dialogs are accessible in the usual way, through the menu or the >>> and <<< bars.

SPECIFYING SYSTEMS OF EQUATIONS

6. A system of equations is specified by checking this option in the main Model dialogs, and then selecting a set of two or more dependent variables. All the equations are given the same specifications (AR/MA components, regressors, etc.). The specification of individual equations is changed by selecting restrictions on individual parameters in the Values dialogs.

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7. To modify the specification of an equation, first open the corresponding Values dialog. Use the choice widget appearing on the tool bar to switch between equations. To exclude a regressor (or lag) from an equation, select the "Fixed" checkbox for the parameter(s) in question, and then make sure that 0 is entered in the Values field. If desired, any other fixed value can be set.

8. Variables selected as endogenous can also appear on the right-hand sides of the equations as Type 1 regressors, to allow a simultaneous system. Three Stage Least Squares can be selected as an option in the Model / Linear Regression dialog. In the Dynamic Equation dialog, the presence of such variables automatically causes the FIML estimator to be computed, provided suitable identifying restrictions have been imposed on the equations. See the relevant help pages for further details.

9. Equilibrium relations can be embedded in systems of equations to create an error correction model or cointegrating VAR. The Model / Equilibrium Relations dialog allows the selection only of a set of variables to be included in all the relations. The Values dialog is used to impose restrictions, which must include a normalizing restriction (fixed at -1, typically) on one variable.

4.1 Model / Linear Regression...

This dialog is for specifying a linear equation, for estimation by Ordinary Least Squares (OLS) or Instrumental Variables (IV/2SLS). When a system of equations is enabled in Setup / Estimation and Sample, it also permits estimation by the three stage least squares (3SLS) and the "seemingly unrelated regressions" (SUR) system estimators.

* Select the type of estimator required under Select Estimator. Note that the options depend on whether the System of Equations checkbox is checked. For IV estimation, select the instruments in the Model / Select Instruments dialog.

* Use the radio buttons to choose whether to specify the dependent variable(s), or regressors of Types 1 or 2. Then click on the variable(s) desired in the list. Any number of regressors of either type can be selected, but only one dependent variable, unless the "Systems of Equations" box is checked in Setup / Estimation and Sample.

* Set the 'Lags' scrollbar to automatically include lags, up to the set order, of all variables of the Type whose radio button is currently selected.

* Use the check-boxes to include an intercept and/or a trend dummy.

* Use the check-box to enable a Wald test of parameter constraints. The type of test is specified in Model / Parameter Constraints (press the square button to open this dialog). Parameters for zero and linear restrictions must be specified in the Values / Equation dialog.

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* Enable the "Cointegrating Regression" options by checking the checkbox. Then:
    - o check either or both of the Cointegration Test checkboxes to compute the residual Phillips-Perron and/or augmented Dickey-Fuller statistics.
    - o Check "Fully Modified Least Squares" to compute the Phillips-Hansen (1990) FMLS efficient estimator.
    - o Check "SSW Efficient Least Squares" to compute the least squares estimator augmented by leads/lags of regressor differences as proposed by Saikkonen (1991) and Stock and Watson (1993) (SSW-LS).

* For Instrumental Variables estimation (IV/2SLS/3SLS), use the Choose Instruments button to open the selection dialog.

* The “Sample …” button opens the Set Sample dialog. Use this to select the observations to be used for estimation. The setting is the same as if opened from Setup / Set Sample. Pressing the "Simulate" button allows the "All Available Observations" button to show the available sample of exogenous variables for a simulation of the dependent variable.

* The Options button opens the most recently opened estimation options dialog from the Options menu. By default, this is the Tests and Diagnostics dialog. Click the horizontal <<<< and >>>> bars in these dialogs to switch between them.

* The Values button opens the equation Values dialog, or refreshes it if it is already open.

* To compute the estimates, press the Go button. This duplicates the 'Evaluate' button on the toolbar, and the Actions / Run Estimation menu item.

Notes:

1. For models specified in this dialog the estimates are computed by the usual analytic formulae. Equations specified in the Model / Dynamic Equation dialog are estimated by numerical optimization, whether or not their form is linear.

2. When this dialog is opened, the Dynamic Equation, Conditional Variance, Supplied Function and Regime Switching dialogs are all closed automatically. These features are all disabled ("greyed out"), until it is closed again. All estimators except Least Squares and IV are also unavailable.

3. See Model / Select Instruments for details of the instrument selection procedure.

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4. Use the 'Clear' button to remove all selections.

VARIABLE AND LAG SPECIFICATION

5. When one or more variables are selected in any category, the corresponding radio button is highlighted (lighter grey). To see the actual variable(s) (highlighted in the variable list) and the lag order selected, click on the radio button in question.

6. Regressors of Type 1 can have a different lag order specified from those of Type 2. It is recommended to (e.g.) make variables for lagging of Type 2, and others, such as dummies, of Type 1. If lags are not specified, then regressors of Types 1 and 2 are equivalent.

7. In single equation mode, if the dependent variable is selected as a regressor of Type 2, and Lags > 0, only its lagged value(s) are included in the set. This provides an alternative way to estimate an autoregression, without numerical optimization. In all other cases (as a regressor of Type 1, or with Lags = 0) the dependent variable is ignored.

8. In Equations System mode, selecting the same set variables as the "Dependent Variables" and as "Regressors of Type 2", with k > 0 lags selected, results in the unrestricted VAR(k) system being estimated.

9. The trend term, if selected with the checkbox, is a regressor of Type 1. With this option selected, lags of Type 1 regressors are disabled to avoid collinearity.

WALD TEST OF CONSTRAINTS

10. Estimation subject to constraints is not available for linear regressions. LM tests of parameter constraints and fixing restrictions are likewise disabled, although parameters can be fixed in the usual way. However, note that Wald and LM tests are equivalent in this case.

11. To perform an F test of “significance of the regression”, check the Wald Test checkbox, and also the "Test Joint Significance of Regressors" box in the Model / Constraints dialog. Note that lagged dependent variables, current endogenous variables in simultaneous systems and the trend term are not included in this set by default, but can be added to it by checking the Wald Test checkboxes in the values dialog..

COINTEGRATING REGRESSION

12. The cointegration options are all disabled if the Systems checkbox is checked, or the Estimator selection is IV/2SLS. The Phillips-Perron and ADF statistics are only available with OLS estimation. These options are disabled if FMLS or SSW-LS are selected.

13. The Phillips-Perron test and FMLS estimator both make use of a Heteroscedasticity and Autocorrelation Consistent (HAC) covariance estimator. Set the desired kernel and bandwidth in Options / Test and Diagnostics Options.

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14. The SSW-LS estimator includes leads and lags of the differences of all variables included as Type 1 regressors. The coefficients of these ancillary regressors are not reported in the output. Lagging Type 1 regressors is disabled. Type 2 regressors can be included, with lags chosen by the user (not chosen automatically). For valid application of the method, the dependent variable and Type 1 regressors must all be I(1), while the Type 2 variables must all be I(0) (stationary).

15. The ADF test and the SSW-LS estimator depend, respectively, on a choice of lag length, and of lead/lag length. The lengths L can be selected in two ways:
    * Automatically, by optimizing a model selection criterion over the interval 0 <= L <= [n^(1/3)] . The selection criterion is is set in Options / Test and Diagnostics. It is the Schwarz IC by default.
    * Manually, using the lag selection scrollbar. To enable this option, set the model selection criterion to "None" in Options / Test and Diagnostics.

16. FMLS and SSW-LS cannot both be selected at once. Uncheck to latter to select the former.

4.2 Model / Dynamic Equation...

This dialog sets up the specifications for a dynamic model. As well as setting the basic ARIMA and ARFIMA specifications, as specified in equation (3.1) of the main document, it also specifies which additional model features will be activated.

* Use the radio buttons to select an estimator. The estimation criteria (see main documentation for details) are:
    - Least Squares / Least Generalized Variance / FIML
    - Instrumental Variables / GMM
    - Conditional Maximum Likelihood with Gaussian (normal) errors
    - Conditional Maximum Likelihood with Student's t errors
    - Conditional Maximum Likelihood with skewed Student's t errors
    - Conditional Maximum Likelihood with General Error Distribution
    - Whittle (frequency domain) ML with Gaussian errors
    - Probit (0-1 binary data)
    - Logit (0-1 binary data)
    - Poisson (count data)
    - Negative Binomial I (count data)
    - Negative Binomial II (count data)

* Use the scroll bars to choose the order of ARMA model.

* Use the checkboxes to select the ARFIMA (long memory) specification, impose a unit root, select a nonlinear moving average (see 16 below) and include intercepts of Type 1 or 2, and a trend dummy. Only one type of intercept can be selected at a time.

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* Use the radio buttons to switch between selection of the four categories of variable: the dependent variable, and regressors of Types 1, 2 and 3. Then highlight the variables required in the list.

* Set the 'Lags' scrollbar to a positive value to include lags, up to this order, of all the variables of the Type whose radio button is currently selected.

* Use the lower scrollbar to select the number of lags of the error to include in the bilinear specification. If set to zero, this corresponds the usual AR(F)IMA(p,d,q) model.

* Use the other check-boxes to select or deselect additional model features (conditional variance model, coded nonlinear function, regime switching, equilibrium relations and parameter constraints). Press the button to the left of the checkbox to open the corresponding dialog, if currently closed.

* For Instrumental Variables estimation (IV/GMM), use the Choose Instruments button to open the selection dialog.

* The "Sample ..." button opens the Set Sample dialog. Use this to select the observations to be used for estimation. The setting is the same as if opened from Setup / Set Sample. Pressing the "Simulate" button allows the "All Available Observations" button to show the available sample of exogenous variables for a simulation of the dependent variable.

* The Options button opens the most recently opened estimation options dialog from the Options menu. By default, this is the Tests and Diagnostics dialog. Click the horizontal <<<< and >>>> bars in these dialogs to switch between options dialogs.

* The Values button opens the equation Values dialog, or refreshes it if it is already open.

* To compute the estimates, press the Go button. This duplicates the 'Run' button on the toolbar, and the Actions / Run Estimation menu item.

Notes:

ESTIMATION CRITERIA

1. Note limitations on the application of some estimators.
    * GARCH and Markov switching options are unavailable with least squares and GMM.
    * Systems of equations are unavailable with skewed Student errors, and all discrete data options.
    * The Whittle method is only implemented for univariate ARFIMA models.

2. If no conditional heteroscedasticity or regime-switching features are specified, the difference between Least Squares/LGV and Gaussian ML is that in the latter case the error variance (or covariance matrix, for systems) is estimated jointly with the other parameters .

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3. Multi-stage GMM, with efficient weights matrix based on first-stage residuals, is effected by running the estimation repeatedly. See Actions / Run Estimation. For this option to be active, the type of covariance matrix desired ('Robust', or 'HAC') must be selected in Options / Test and Diagnostics Options. If 'Standard' is selected, only one-step GMM is available.

4. "Binary data" means that the dependent variable may take only two values, zero and one.
"Count data" means that the dependent variable may take only zero or positive integer values.

MODEL SPECIFICATION

5. Check the 'Impose Unit Root' option to estimate an ARIMA(p,1,q) model, and also an ARFIMA(p,1+d,q) where -0.5 < d < 0.5. This option is distinct from performing the estimation on the pre-differenced series, because the regression statistics, plots and forecasts are all generated for the original series of levels.
Note:
   * Any Type 1 regressors included are differenced along with the dependent variable(s).
   * If a trend is included, it becomes in effect an intercept for the differenced model. A Type 1 intercept is unidentified, and is not permitted. A Type 2 intercept can enter as an alternative to the trend, but will be suppressed if a trend is specified.
   * Type 2 and Type 3 regressors enter as usual, and are not differenced.
   * Lagged dependent variables, included as either simple regressors of Type 2 or as components of equilibrium relations, are not differenced.
   * In fractional cointegration models, the program modifies the reported value(s) of d3 in the appropriate way, such that 1 is added to the order of difference d1, as reported.

6. Use the 'Values' button to open the relevant Values dialogs, and update them with new settings if already open. Use the 'Clear' button to remove all selections in this dialog. The 'Go' button launches an estimation run (duplicates the Run button and Actions / Run Estimation).

VARIABLE SELECTION

7. The three regressor Types correspond to the vectors denoted x_1t, x_2t and x_3t in equation (3.1) of the main document. Therefore, the estimated coefficient of a particular regressor can be different depending its Type, when AR and/or MA components are specified. Type 1 and 2 intercepts must be interpreted similarly.

8. When one or more variables are selected in any category, the corresponding radio button is highlighted (lighter grey). To see the actual variable(s) selected (highlighted in the variable list) click on the radio button in question.

9. Only one variable can be selected as dependent, unless the "Systems of Equations" box is checked. Multiple selection is allowed in the regressor

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categories.

10. The 'Lags' setting allows different orders of lag for the regressors of each Type. For example, include variables for lagging in the Type 2 category, and non-lagged variables such as dummies in the Type 1 category. Individual lags can be suppressed by 'fixing' the coefficients at zero in the Values dialog. If neither lags nor ARMA components are selected, and there are no current endogenous variables, the regressor Types are all treated equivalently.

11. If the dependent variable is selected as a regressor of Type 2, and Lags > 0, only the lagged values are included. This provides an alternative way (from setting AR Order > 0) of including the lagged dependent variable as a regressor. This feature is for compatibility with the Linear Regression option.

LINEAR REGRESSION

12. A linear equation can also be specified in the Model / Linear Regression dialog, and in that case will be estimated by the usual analytic formulae. Models specified in this dialog are always estimated numerically.

13. This dialog and the Linear Regression dialog cannot both be open at once. One is disabled whenever the other is open. The variable selections (Type 1 and 2 regressors) are common to both.

14. An autoregression can be estimated either in this dialog, numerically, or as a linear regression by using the Lags feature (see 5 above).

BILINEAR MODEL

15. Remember that if the bilinear order (r) is increased from 0 to 1, this adds p parameters to the model , where p is the AR order. However raising r further only adds one additional parameter at each step (not p) due to the imposed restrictions. This is different behaviour from the commonly described unrestricted bilinear model.

NONLINEAR MOVING AVERAGE (SPS)

16. Selecting this feature replaces the error term Ut with the expression
    Ut - Ut-1(alpha + beta/(1 + exp(gamma*(Ut-1 - c1)*(Ut-1 - c2))))
    where alpha, beta, gamma, c1 and c2 are additional parameters.
    Combine this option with an imposed unit root to get models which can switch stochastically between I(0) and I(1).

17. Variants:
    * To implement a close approximation to the STOPBREAK model, fix alpha = -2, beta = 2, c1 = c2 = 0 .
    * To obtain the STIMA model, fix gamma =100 (or any sufficiently large value), impose the constraint c1 = -c2. Then, alpha is the MA coefficient for small deviations (|Ut-1| < c1) and alpha + beta for large deviations.
    * Alternatively, all the parameters can (in principle) be freely estimated.

18. Nonlinear MA models can also be implemented by coding the required

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formula, see Models / Coded Equations. If both options are selected, this one is over-ridden.

OTHER MODEL FEATURES

19. The selectable model features are conditional variances (ARCH/GARCH), coded functions, regime switching, equilibrium relations, and constraints. Select these features to be included in the model with the checkboxes at the lower left side of the dialog.

20. If a feature checkbox is "greyed out" (disabled) this means that the feature is unavailable with current settings, usually choice of estimator. For example, conditional variance models need an ML estimator to be selected. Also, "Coded Function" is greyed out if coded equilibrium relations are specified in the Equilibrium Relations dialog. For this case the Coded Function dialog is dedicated to specifying equilibrium relations.

21. Model features generally require options to be set in the corresponding dialogs to be active. It is not possible to select a feature with the checkbox, unless some model options have been set.

22. Click the square buttons to the left of the checkboxes to open the corresponding dialogs. If options are set, these buttons are highlighted. The dialogs can also be opened from the Model menu.

23. NOTE: Values dialog(s) corresponding to model features (equilibrium relations, switching regimes) are not accessible unless the feature is checked.

24. To compute a Wald test as part of the run, as well as to estimate subject to constraints, the "Parameter Constraints" box must be checked. Wald tests can also be performed separately, see Actions / Compute Test Statistics / Wald Test.

SYSTEMS OF EQUATIONS

25. Select system estimation by checking the "System of Equations" checkbox.

26. When a system of equations is specified, the estimator computed depends on the estimator selection.

    * If the option "LGV/FIML" is selected, the log-determinant of the error covariance matrix is minimized (Least Generalized Variance), or FIML in the simultaneous equations case (see 22 below). In these cases, the covariance parameters are concentrated out, and do not appear in the vector of parameters.

    * If the option "IV/2SLS/GMM/3SLS" is selected, the estimation method is system GMM with the instruments selected. If the estimation is launched with the Actions / Run Estimation commands or the "Run" button, the error covariance matrix set equal to the identity matrix. However, if the command Actions / Multi-Stage GMM is given twice in succession, the second run uses the efficient weights matrix estimated from the current residuals. This iteration

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can be repeated as often as desired. The form of the weights matrix used depends on the Covariance Matrix Formula setting (see Options / Tests and Diagnostics), either standard, robust (allowing for heteroscedasticity) or HAC.

* If the Gaussian ML, Student t ML or GED ML estimation options are selected, the error variances and contemporaneous correlations are estimated as additional parameters. The variances may be modelled by ARCH and other processes by selecting the "Conditional Variance Model" feature. These parameters (variances and correlations) can also be subject to regime switching.

27. If current endogenous variables are included as Type 1 regressors, the FIML variant of the LGV and ML estimators is automatically selected. That is, the log-determinant of the square matrix of coefficients is incorporated in the maximand. Suitable identifying restrictions must be imposed on the coefficients for this option to proceed. The "coefficient" of the normalized variable in each equation is automatically fixed at 0 in this case.
Note: Endogenous variables specified as Type 2 regressors are ignored. If lags are specified, only the lagged values are included.

28. In a VARFIMA model, it is possible to parameterize the fractional difference parameters for Equations 2,... as the differences from the parameter of Equation 1. This makes it easy to constrain and test equality of the parameters across equations. To select this option, set the third checkbox in the Model / Equilibrium Relations dialog. This setting applies even if error correction terms are not specified.

ESTIMATING TYPE I (V)ARFIMA PROCESSES

29. It is possible to correct for the omission of the presample data in a fractionally integrated model by including some generated regressors (depending on the d and variance parameters). This option is enabled by setting the "Type I Fractional" text box in Options / General to a positive integer value, corresponding to the number of generated regressors to be included. In the output the estimated coefficients are denoted typeIFrac-Z1, typeIFrac-Z2,.... These are akin to principal components of the omitted stochastic terms.

30. Recommended settings are for the number of components are 1 or 2. The columns of higher order are very small, so including too many may produce unstable results.

4.3 Model / Conditional Variance...

This dialog sets up the specifications for equations (5.1)/(5.2) or equations (6.1)/(6.2) of the main document. In the latter case, the specification set applies to the conditional variances of each equation.

* Use the scroll bars to choose order of GARCH specification.

* Use the radio buttons and checkboxes to select other model options.

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* Use the radio buttons to switch between selection of the three possible types of GARCH regressor, then click on the variable list to make the selections.

* Distributed lags of the GARCH regressors can be specified using the 'Lags' scrollbar, just as in the conditional mean model.

* Check the "Abs." checkbox to take absolute values of the regressors automatically.

Notes:

1. This menu item is checked if a conditional variance model is specified. Its settings are ignored unless a ML estimator is selected and "Conditional Variance Model" is checked in the Model / Dynamic Equation... dialog.

2. The 'regressor' radio buttons are highlighted (lighter grey) to show a selection has been made.

3. Clear all specifications with the Clear button.

4. If the 'GARCH' radio button is selected, the 'Asymmetry' checkbox selects the Threshold GARCH (GJR) model. In the other cases, the signed terms of the APARCH or EGARCH are included/suppressed, depending on the setting of this checkbox.

5. The dependent variable(s) in the equation(s) can be chosen as GARCH regressors of Type 2, provided the lag length is set to 1 or greater. In this case the zero-order lag is suppressed, and the lagged dependent variable(s) act as GARCH regressors. This is similar to the option in the mean model. Dependent variables are NOT permitted as regressors of Types 1 or 3. These options are cancelled automatically.

6. If the 'Abs' checkbox is checked, the output shows the variable names enclosed in "|" . It is recommended to check this option when lagged dependent variables are selected, especially when running simulations.

7. The Garch-M panel allows either the conditional variance, or conditional standard deviation, to be added to the regressors selected in Equation… Choose the regressor Type, and Mode, using the radio buttons.

MULTIVARIATE GARCH

8. If the equation system option is selected, the default is to have fixed correlations between the variance-adjusted residuals. An alternative is the DCC model, in which the elements of the correlation matrix are generated by a common GARCH(1,1)-type model. The interpretation of the coefficients depends on the setting, standard vs. "ARMA in squares" form, see Options / ML and Dynamics. In the first case the fitted parameters are alpha and beta, in the second case they are delta = alpha + beta and beta. Note:
   1) The DCC parameters are displayed in the Values / Distribution dialog.

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2) The MA form setting in Options / ML and Dynamics does not affect the DCC specification.

9. If a multiple equation model is specified, the BEKK-Multivariate Garch model can be selected. This is the case K = 1 as defined by Engle and Kroner (1995). Be careful to interpret the parameters correctly in this case. Selecting Equation i in the Values / Conditional Variance dialog, using the choice widget, displays the ith columns of the Aj and Bj lag polynomial matrices, and although note that these matrices really define the dynamic structure of the vectorized conditional covariance matrix, Vec H_t. See the main document for details of the model. The estimates are reported in the results window in the same style.
Note: Neither the MA form nor the GARCH form options (Options / ML and Dynamics) affect the BEKK parameterization.

10. Evaluation of the DCC and BEKK likelihood functions both require T NxN-matrix inversions, where T is the sample size and N is the number of equations. Function evaluation could therefore be very slow for large systems.

11. If the BEKK option is selected, the GARCH_M variables consist of the conditional variances and covariances of all equations. The SD mode is not available in this case.

12. In a system of equations with multivariate FIGARCH or HYGARCH disturbances, it is possible to parameterize the fractional difference parameters for Equations 2,... as the differences from the parameter of Equation 1. This makes it easy to constrain and test equality of the parameters across equations. To select this option (which will also apply to VARFIMA parameters, if specified) set the checkbox in the Model / Equilibrium Relations dialog. This works even if error correction terms are not specified.

4.4 Model / Coded Function...

This dialog is used to set up nonlinear functions coded by the user. Coded functions can form complete models for estimation, or components of models. Test statistics can also be coded. See the main TSM document, Section 3.2.8, for the details. The dialog is also used to specify coded functions for simulated data generation.

* Specifications created in this dialog are ignored unless the "Coded Function" checkbox in Model / Dynamic Equation is checked. The checkbox cannot be checked unless a specification exists.

* The "Clear" button clears all text fields, both the parameter names and the contents of the formula fields. Use with caution!

* The "Clear Built-In Components" button is provided as a convenience, for the case where the coded function represents the complete model.

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Then, all other model features need to be disabled. In particular, make sure that items such as the built-in intercept are deselected, to avoid duplication and an unidentified model.

METHODS

There are three ways to code a model for estimation:

I. Type coded formulae for equations or equation components into the text box, interactively.

II. Supply the code for the model equations as an Ox function, and compile this with the program.

III. Write Ox code as in II, but for the complete likelihood function.

Method I is easiest to implement, but limits the function to a single line of code. Methods II and III allow any degree of generality, but require a minimum of programming expertise. Since the function is compiled with the program, TSM must be stopped and restarted to make changes to the specification.

INTERACTIVE CODING

To set up the model, do as follows:

1) Open the Model / Coded Equations dialog, and select one of the radio buttons "Equation", "Residual", "Nonlinear MA" and "Nonlinear ECM".
2) Select the dependent variable(s), in the usual way, in the Model / Dynamic Equation dialog.
3) Type the equation formulae in the text fields. Use "Previous" and "Next" to navigate the fields, "Clear" to initialize the formula and "Cancel" to discard changes and revert to the stored text.
4) Press "Test" to check the model parses OK, and list the parameter names in the name fields below.

Notes:

1. See Section 1.5 (General / Entering Formulae) for detailed instructions on entering codes into the text field.
2. Parameters removed from the equation are not deleted automatically, but are 'suspended'. Clear the name field manually to delete a parameter permanently from the model.
3. Increase the 'Maximum Parameters' value and refresh the dialog to display additional fields.

TYPES OF FORMULAE

"Equation" The equation is entered explicitly, in the format " = [Formula]", where the formula corresponds to the explained part of the model, and implicitly the dependent variable named in the heading appears on the left of the "=". The residuals (corresponding to the function f1(.) in equation (3.29) of the main document) are computed as the difference between the left- and right-hand sides of the equation. Use this style whenever the model can be represented in the form required - which is most cases.

"Residual" Enter an expression which itself equates implicitly to the residuals of the model (f1(.) in equation (3.29)). In this case, no "=" sign

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should appear in the formula. The purpose of this option is to allow models in which the dependent variable(s) enter(s) nonlinearly. Since the model cannot be solved automatically, no Actual/Fitted plots, forecasts or simulations are available in this case. This option is also used for the formulation of equilibrium relations for ECM models.

"Nonlinear MA"

With this option, the model disturbance term Ut is replaced by the moving average formulation

Ut = Et - f3(Et-j, j > 0).

Enter the formula for the function f3(.) using the reserved variable names E#{-j}to represent the disturbances lagged j periods. (E here corresponds to v in equation (3.29) of the main document.) As in "Residual" the formula should be in implicit form, do not include "=".

In multi-equation models, use the variable names E#1{-j}, E#2{-j}, ..., to represent the disturbances for each equation. Presample lags are replaced by 0.

Notes:

1. With this option the function has to be evaluated recursively. Iterative estimation of these models could be time-consuming!
2. A pre-programmed nonlinear MA model can be accessed from the Model / Dynamic Equation dialog, and should be faster to estimate than the coded version. Use this option except to implement other variants. If both options are selected, the coded version takes priority.

"Nonlinear ECM"

In error correction models, equations can contain nonlinear functions f2(Z) of the lagged equilibrium relation Z. Three popular forms are pre-programmed. For other cases, enter the function(s) f3 in implicit form, using the reserved variable name Z# to denote the equilibrium relation or, in case of two or more relations, the names Z#1, Z#2, ...

Lags can be included as Z#{-j} for j>0. Note that the lag j is relative to the minimum lag specified in the Model / Equilibrium Relations dialog. Presample lags are replaced by 0.

Notes:

1. For the Equation option, an equation code must pair with a selected dependent variable - see the field heading. It is not possible to add an equation without first selecting a variable. Equations can be validly entered in the explicit format "Dependent Variable = [Formula]". The name of the dependent variable is added implicitly, if omitted.

2. In the Residuals option, the dependent variables must still be selected even though there is no explicit normalization. The number of equations formulated must be equal the number of selected variables. Checking that the formulated equations have a solution for the chosen

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variables is the responsibility of the user.

3. For the Residuals option, the typed equations define the model to be estimated. Dependent variable selections in Model / Dynamic Equation are ignored! Be sure to delete any unwanted equations using "Clear".

4. When "System" is checked in Models / Dynamic Equation, and two or more endogenous variables are selected, coded specifications can be created for each equation. Switch between these with the "Next" and "Previous" buttons. If no function is specified for a variable, enter "= 0" in the corresponding field.
   NOTE: Simultaneity is not allowed!!
   * "Equation" specifications should contain ONLY exogenous or lagged endogenous variables on the right-hand side.
   * "Residual" specifications may be estimated, subject to the caveat of containing only one endogenous variable each, but may NOT be used for simulation.

   It is the user's responsibility to respect these restrictions. The program cannot monitor violations, and incorrect estimates and simulations will result!!

5. When the "Coded Equilibrium Relations" option is selected in the Model / Equilibrium Relations dialog, only the Residuals option is selectable in this dialog.

TEXT BOX CONTROLS

"Cancel"	Discard changes and restore existing formula.
"Clear"	Clears displayed formula. Enters left-hand side for "Equation" entry.
"Next"	Displays the next formula, where present, disabled otherwise.
"Previous"	Displays previous formula where present, disabled otherwise.
"Test"	Tests parsing of the current model equation(s).

Closing the dialog with the Windows Close button [x] is equivalent to pressing "Cancel".

PARSING THE MODEL

Parsing fails in cases including the following:
* Variable name does not match any variable in the data set.
* Non-matching or misplaced brackets/parentheses/braces.
* Missing/misplaced operators.
* Wrong left-hand side variable ("Equation").

An error message is displayed in a pop-up window, and should assist the debugging process

Note: A name not appearing in either the variable list or current parameter list is assumed to be a new parameter, and added to the list. Check the list carefully to see if it's what you intend.

PARAMETER NAMES

* "P[i]" where "i" is the parameter number shown beside the text field, is always a legitimate choice of name. It must be still typed explicitly in the

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field, so that the program knows how many parameters are specified.

* Nine parameter name fields are displayed by default. To change the number, type the value in the "Maximum Parameters" field. To redraw the dialog box click any button, e.g. "Cancel".

* Be careful that parameter names do not duplicate variable names. The convention of naming a coefficient by the variable it multiplies must be avoided here!

* In multi-equation models, the same names appear in each equation, but refer to different parameters. They are distinguished in the output by prefixes "Eq1:", "Eq2:" etc.

* If a parameter is named but does not appear in an equation, it is fixed at 0 in that equation. It appears in the Values dialog, but is suppressed in the output. This allows equation-specific parameters to be named distinctively

VARIABLE NAMES

* These can be spelled out in full or replaced by the short form "x[i]" where "i" is the position of the variable in the list, starting from 0. The line numbers are displayed in the variable list in Models / Dynamic Equation whenever the text field is open.

* Under the "Equation" coding option, select the the dependent variable(s) in the Model / Dynamic Equation dialog first. Unless the formula fields already contain formulae (press Clear to delete these), opening a field will automatically insert the variable name and " = ", ready for the rest of the formula to be typed.

OX CODING

See Appendix C of the main document for information on compiling supplied code into the program.

Supplied Ox code can be used to return five types of object, according to the selection made with the radio buttons -

Residuals: Return a vector/matrix of equation residuals, as a function of data and parameters from UserEquation(). Return solved values and forecasts from UserSolve().

Log-likelihood: Return a vector of log-likelihood contributions as a function of data and parameters from UserLikelihood().

Statistic: Return a statistic or vector of statistics as a function of data and optional constants (passed as parameters) from UserStatistic().

Data Generation: Return a generated data set as a function of existing data and constants passed as parameters from UserGenerate().

Test Only: Choose this setting if the only coded function to be returned is

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a test statistic from UserTest(), based on the regular estimation outputs, selected with the "Test" checkbox. If this option is set, the "Coded Function" checkbox is automatically deselected.

Notes.

1. If the coded functions have been set up for selection by name, as described in Appendix C, they can be selected in the dialog using the Previous and Next buttons to navigate the list. Preset names cannot be edited. If no naming function has been defined, a function can still be selected by typing its name into the field.

1. The test statistic option, from UserTest(), accessed by checking the "Test" checkbox, is compatible with any estimated model. This includes linear equations, and the Ox Residuals and Log-likelihood options, but not Statistic or Data Generation.

2. If a coded test is the only programmed option, select "Test Only" and do NOT check the "Coded Function" checkbox in Model / Dynamic Equation.

3. If "Coded Equilibrium Relations" is selected in Model / Equilibrium Relations, and "Equilibrium Relations" is checked in Model / Dynamic Equation, the "Coded Function" checkbox in in Model / Dynamic Equation is disabled. Note that in this case the parameter values for the coded relations are displayed in Values / Equilibrium Relations

4. For all options except the coded test and coded equilibrium relations, the "Coded Functions" checkbox must be checked in Model / Dynamic Equation to activate the option.

5. Enter names of parameters in the text fields provided in the dialog. Optionally, an identifying name can be entered in the 'Function Name' field. This is used to identify the output and can also select the function from a code library maintained in the run file. Alternatively, a name can be passed from the function itself. To activate this option, leave the Function Name field blank.

6. When residuals or the log-likelihood are returned, setting dependent variable(s) in the Model / Dynamic Equation dialog is optional, though recommended. If set, it/they should correspond to the normalized variable(s) in the supplied functions. These settings are not used to compute the estimates, but allow the correct plots, series and forecasts to be generated.

7. It is the user's responsibility to set the sample period (see Setup / Set Sample) to ensure that all observations are available for the variables in the model. This is done automatically for models specified through the program options, but the program cannot know whether variables included in the user's function have missing observations.

8. For statistics and data generation, there is the option to enter names

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for constants in the parameter name fields, then set values for these in the Values / Equation dialog. These values are not modefied by TSM, but are passed through directly to the user's function. If this feature is utilised, it provides a means for quick changes of specification, without editing the code.

9. To generate data, "placeholder" variables must exist in the data set. The contents of these columns is unimportant, being replaced by the generated series when the simulation runs. For example, they can be created using the Extend Sample, Make Zero and Rename commands in Setup / Data Transformation and Editing. Then select these variables as the Dependent Variable(s) in Model / Dynamic Equation.

4.5 Model / Regime Switching...

This dialog allows the choice of

* number of regimes,
* type of switching - simple Markov switching, explained switching, Hamilton's model, or smooth transition (ST).
* which model components to switch,
* specification of the explained switching probabilities or transition function, where these options are selected.

Notes:

1. Regime switching is not activated until at least one model component is selected for switching!

2. Except for the smooth transition model, regime switching requires a time-domain maximum likelihood estimator. Options are "greyed out" until a valid selection is made.

3. In the Markov and Hamilton models, both the matrix of estimated transition probabilities p_{ji}, and the unrestricted parameters t_{ji} with standard errors are reported in the output. The latter are labelled "Logistic of P(j|i)". See the main document for details.

4. In Hamilton's model, the "Intercept" selection in Models / Dynamic Equation is ignored. The intercept is specified as shown in the TSM document.

5. In the explained switching case, the radio buttons allow the choice of variables to explain the probability of switching into the given regime at date t. An intercept can be optionally added to the equation.

6. Distributed lags are not implemented for switching regressions, but the 'Lag' scrollbar allows a fixed lag to be applied to the variable(s). If and only if the lag is positive, the dependent variable(s) can be included in the set.

7. There are two versions of the explained switching model. In the first

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version, the equation for the probability of switching into regime j at date t may depend on the current regime (i) only through an intercept shift, by inclusion of a dummy variable for the intercept in question, with Regime 1 as the reference case. In the second version, the switching equations may be fully regime-dependent, and switch just like other model components. Check the box "Regime-Dependent Coeffs." to enable this case.

8. The second explained-switching model contains the first one as a special case, but the latter is set up in a slightly different way, with regime dummies, and is retained for backwards compatibility and simplicity. If dummies (or switching intercepts) but no explanatory variables are specified in explained switching, the model represents an alternative parameterization of the regular Markov-switching model. In form, log-odds transformations of the switching probabilities are estimated as unconstrained parameters, and standard errors and test statistics are implemented.

9. In the smooth transition (ST) case, select the transition indicator (z_t) from the variable list after clicking the first radio button. Only one selection is possible. If no transition indicator is selected, the smooth transition option is cancelled and the type setting reverts to Markov switching.

10. The inclusion of an ST intercept is selected by a checkbox. If both this and explanatory variables are omitted, the dominant regime depends on the sign of z_t. The second set of parameters is unavailable unless 'Double Transition' is checked.

11. The number of regimes is fixed at 2 for the ST model.

12. If the type of switching selected changed from either explained switching or smooth transition, the variable selections for those options are cancelled.

13. The option "Estimate Regime Differences" selects the parameterization that allows individual significance tests of differences between the regimes. However, note that in a test for *no* differences between regimes (= test for number of regimes) the switching probabilities or ST parameters are unidentified under the null hypothesis. This is a well-known testing pitfall, and the standard tests don't apply.

14. If "Estimate Regime Differences" is selected with Markov or Hamilton switching, then rows 2,...,M of the Markov transition matrix are likewise expressed as differences from row 1. This allows a test of the hypothesis that transition probabilities are independent of the current regime.

15. Analytic forecasts are not available for ST models in this release. Use the Monte Carlo forecast option.

16. Analytic forecasts are available for the Markov switching models. However, the number of calculations needed to compute the multi-step forecast 2-standard error bands increases exponentially with the number of steps, and can become excessive. Standard error calculations are terminated after 100 seconds has elapsed, and only the point forecasts

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are reported for further steps. A warning message is printed in this case. The SE bands can also be omitted, see Options / Graphics.

17. The ST model has two identical maxima of the likelihood, since interchanging both the regimes and the sign of the smoothness parameter (gamma) yields the same likelihood, by construction. Be careful to interpret the estimates correctly.

4.6 Model / Parameter Constraints...

This dialog sets options for imposing restrictions on the coefficients.

Three types of restrictions can be set up:
a) zero restrictions,
b) multiple linear restrictions, and
c) general restrictions specified as coded formulae.

In case (b), only the constants (intercepts) of the constraint functions are set in this dialog. The linear functions themselves, like the parameters for zeroing, are set in the Values dialogs.

Restrictions can be implemented in either of two ways:
* Tested on the unconstrained estimates, using the Wald principle,
* Imposed in estimation.

In the latter case, the LM test for the restrictions is computed, if this option is selected in the Options / Tests and Diagnostics dialog. In this case, any fixing restrictions on the parameters will be treated as part of the maintained model and not tested. To test fixing restrictions, make sure the Parameter Constraints option is deselected in Model / Dynamic Equation... or Model / Linear Regression

Notes:
1. Up to 10 linear restrictions can be specified with nonzero constant terms. However, up to 20 additional restrictions could be set with zero constant terms.

2. Estimation subject to constraints is not available with OLS and IV estimation. This option is disabled ("greyed out") when the Model / Linear Regression dialog is open.

3. By default, the statistic reported is asymptotically chi squared. Set the check box to report the F statistic, with the reported p-value taken from the F tabulation. Note that this setting is shared with the user-specified LM and moment tests (see Actions / Compute Test Statistics). It can be selected/deselected in any of the relevant dialogs.

REGRESSOR SIGNIFICANCE TEST

4. The option "Test Joint Significance of Regressors" provides a valid time series implementation to the "F test of the regression" computed by many

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packages.

5. In a single equation it sets up a Wald test of the joint significance of all regressors in the mean model, all Types and components of equilibrium relations (if any) but excluding the intercept, trend and seasonal dummies, and lagged endogenous variables. The null hypothesis can therefore be set up as a univariate time series representation of the dependent variable. Note that this test can be performed in the usual way by selecting the parameters individually in the Values dialogs, but this option provides a handy shortcut.

6. The program "knows" a regressor is a seasonal dummy if the string "seasonal dummy" or "seasonal dummies" is part of the data description. This is set up automatically if the dummies are generated in Setup / Data Transformations and Editing.

7. In equation systems, all exogenous regressors of all types in all equations and in equilibrium relations are included in the test, but intercepts, trends and current and/or lagged endogenous variables are excluded. "Endogenous" means any variable explained by the system.

8. Additional parameters can be added to the test set in the usual way, by checking the relevant "Wald Test" box in the Values dialogs.

9. Variables having parameters "fixed" are excluded from the test.

CODED_RESTRICTIONS

10. A coded restriction on the parameters is set up by typing the equation into a text field. After selecting the restriction type with the radio button, press the Code button to open the text box.
TEXT BOX CONTROLS

"Cancel"	Close box, discarding changes.
"Delete"	Delete the currently displayed formula.
"Next"	Displays the next formula, where present.
"New"	Opens a new blank formula where there is no "Next".
"Previous"	Displays previous formula, where present.
"OK"	Closes the text box and stores current formulae.
[Return]	Equivalent to pressing "OK".

Closing the dialog with the Windows Close button [x] is equivalent to "Cancel".
For information on entering formulae, see Section 1.5

11. Parameters can be written in the notation "a[i]" where "i" is the number appearing in the left-hand column in the Values dialogs. "p[i]", "A[i]" and "P[i]" are all permitted variants, but the square brackets are mandatory, note.
CAUTION: Parameters can also be identified by name. However, some parameters are named differently in the Values dialogs and in the output. If in doubt use the number notation, which is unambiguous.

12. Suppose there are P restrictions. Using the numbering notation

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described in Section 1.5 (in practice, parameter names can also be used) the restrictions must be entered in the solved form
a[j1] = f1(a[k1],...,a[kM])
...
a[jP] = fP(a[k1],...,a[kM])
for k1,...,kM not equal to j1,...jP, where f1(),..,fP() are differentiable algebraic expressions. The program imposes the restrictions by replacing a[j1],...,a[jP] with the given functions of a[k1],...,a[kM].

13. Restrictions cannot be entered in implicit form!
Example:

```
a[0]  = a[1]*a[3];
a[2] = exp(a[1] - a[4]);
```

is OK.

```
a[0]  = a[1]*a[2];
a[2] = a[1] + a[3];
```

is NOT valid! (Not solved form.) A valid form of the first equation would be

```
a[0] = a[1]*(a[1]+a[3]);
```

4.7 Model / Equilibrium Relations...

An Equilibrium Relation (Eq.R.) is defined as a linear combination of lagged variables that is inserted as a "regressor" in one or more equations of a system, with the combining coefficients being either restricted or estimated. This is sometimes called an Error Correction Model (ECM). Most often, an Eq.R. has the interpretation of a cointegrating relation in a system of I(1) variables, although it could also, in principle, appear in a model of stationary processes. Eq. R.s can also appear in single equations, in which case they implement a re-parameterization of the dynamic model in "ECM" form.

* Choose one of the three options for specifying the equilibrium relation(s).
  - A: Select "Linear Equilibrium Relations" to specify the relation(s) by choosing variables from the list.
  - B: Select "Nonlinear AR / Closed VECM", to include the set of dependent variables as lagged regressors automatically.
  - C: Select "Coded Equilibrium Relations" to specify nonlinear equilibrium relations using the Coded Function dialog.

* Use the first scroll bar to select the number of Eq.R.s to be included in the model.

* Use the second scroll bar to chose the lag to apply to the Eq. R.s (must be >0).

* Restrictions on each relation are set up in the Values \ Equilibrium Relations dialog.

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Notes:

Options A and B

1. Every Eq.R. must contain at least one fixed coefficient, otherwise the relation will be unidentified. Set the fix in the Values / Equilibrium Relations dialog. If no restriction is set manually, the first coefficient in the list will automatically have its coefficient set to 1 when the estimation is run.
   Note: The Values button is highlighted if two or more coefficients are restricted in any relation.

2. With two or more Eq.Rs, note that this dialog specifies the variables to appear in all of them. To create distinct relations, exclusion restrictions (fixing coefficients at 0) must be set up in Values / Equilibrium Relations.
   Note: For consistent estimation, the relations should satisfy the standard rank conditions for identification of a linear system.

3. When "Closed VECM" is checked, the lagged variables included in the VECM are the dependent variables LESS the fitted combination of Type 1 intercept and/or Type 1 regressors. See main TSM document for details of the specification.

Option C

4. The equilibrium relations are formulated in the Model / Coded Function dialog. Note that "Residual" format must be used (no "=" in the field). This is the only permitted option when option C is selected in this dialog.

5. When "Coded Equilibrium Relations" is checked, and "Equilibrium Relations" is also checked in the Model / Dynamic Equation dialog, the "Coded Function" checkbox is disabled - coded functions can appear either in the main equation(s) or in equilibrium relation(s), but not both at once.

6. The number of relations in the model is determined by the number specified in the Model / Coded Function dialog. This overrides the setting in this dialog.

7. Formulating the relations with enough restrictions to ensure identification is entirely the responsibility of the user. Use this option only if you know what you are doing!

8. The specification of the relations can be different when there are two or more of them. They nominally contain the same parameters, but these can be automatically fixed at 0 if not included in a particular relation. See Model / Coded Functions for details. They can also be restricted in the The Values / Equilibrium Relations dialog, if desired.

All Options

9. Eq.R.s are only included in the model if this feature is selected in Model / Dynamic Equation.

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10. The radio buttons in the "Types of ECM" area allow selection of nonlinear response mechanisms as well as the usual Linear case. See the main document for details. Three popular variants are pre-coded. Use the Model / Coded Function dialog to define other cases.

11. Check the first checkbox in the "Fractional Cointegration" area to implement a fractional cointegration (F-VECM) model. Note that this option is ignored unless the VARFIMA / Fractional VECM box is checked in the Dynamic Equation System dialog. In this case, setting the "Impose Unit Root" option causes the estimated value(s) of d1 to be smaller by 1 than otherwise. This is taken into account in the calculation of the cointegration order(s) d3, such that the equilibrium relations appear differenced to order 1+d1-d3 in the system.

12. Check the second checkbox to select the generalized cointegration model. In this case, the cointegrating variables may be fractional differences of the measured variables. See the main document for details.

13. Check the third checkbox to parameterize the fractional integration parameters for Equations 2,... as the differences from the corresponding parameters in Equation 1. This option allows the restriction of equal fractional integration parameters across equations to be easily tested, and imposed in the usual way, by setting the "Fixed" checkboxes in the values dialogs.
NOTE: It is not necessary to specify a fractional VECM to set this option. It applies also to a regularly-cointegrating or non-cointegrating VARFIMA model, and also to the fractional lag parameters of a system FIGARCH or HYGARCH specification.

14. If "Impose Unit Root" is specified in Model / Dynamic Equation, the VECM is estimated with unit roots imposed in the short-run dynamics, while the Eq. R.s enter as lagged levels.

4.8 Model / Select Instruments...

This dialog is enabled only if IV/GMM is the selected estimator.

Highlight by clicking with the mouse those variables to be included as instruments. Use the checkboxes to indicate whether the intercept and trend dummies, and lagged endogenous variables, are to be used as instruments.

The Clear button unselects all variables.

Notes:
1. Any variable appearing in the equation but not in the instrument list is treated as endogenous.

2. Any variable appearing in the instrument list but not in the equation is an additional instrument. Lags of additional instruments are included to match the lag setting for Type 2 regressors. Even if no Type 2 regressors appear,

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the lag length can be set, to control the number of lags of additional instruments.

3. By default, lagged endogenous variables are not used as instruments. If this option is selected with the checkbox, lags are included to match the lag setting of the endogenous variables' Type(s).

4. To use lagged endogenous variables as instruments but not as regressors, suppress them in the equation by fixing their coefficients at 0 in the Values dialog.

5. Lags can be be created manually for use as instruments in the Setup / Data Transformation and Editing dialog. However, be careful with the automatic lag settings in this case. If lags are double-counted, the instrument matrix will be singular!

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5. Values

5.0 Values: General

The Values dialogs are used to operate on model parameters. They allow

* setting starting values for the search algorithm.
* fixing parameters at chosen values in the estimation.
* setting bounds on parameters, for estimation subject to inequality constraints.
* setting a range for a grid evaluation of the estimation criterion, in one or two dimensions.
* selecting parameters for Wald significance tests.
* setting up linear functions of parameters for Wald restrictions tests.

Unlike the other dialogs having fixed layout, Values dialogs can be resized. Grab the border and drag with the mouse.

BUTTONS

1. The "Refresh" button rewrites the values field to reflect changes to the model specification. Pressing the "Values" button in the relevant Model dialog has the same effect.

2. The "Clear" button refreshes the fields after setting all values to defaults.

3. The Equation and Equilibrium Relation dialogs have buttons for cycling through equations/relations. An alternative navigation method is to use the choice widget on the tool bar.

4. All dialogs except Markov Probabilities and Smooth Transition have a "Next Regime" button that appears when switching regimes are specified. Note that if the parameters in question have not been selected to switch, then Regime 1 shows the common values for all regimes, and the dialogs for Regime 2 and above are blank.

5. All dialogs have a checkbox for selecting parameter bounds and grid plotting. This shows/hides two columns of text fields for entering bound values - see paras 10-14 below. Checking/unchecking the box in any dialog effects the setting in all the Values dialogs

VALUES FIELDS

6. The values attained in an estimation run are displayed in the Values fields to double-precision machine accuracy. These provide the starting values for a new run, and can be edited.

FIXED PARAMETERS

7. Check 'Fixed' to fix the parameter at the value set, during estimation. Applications of this feature include:
   * Suppressing intermediate lags in ARMA/GARCH models (fix the values at zero).
   * Temporarily restricting a model, without changing the specifications.
   * Computing LM tests of the corresponding restriction(s) - see

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Options / Test and Diagnostics Options.

* Evaluating the optimized likelihood over a grid of points - see paras. 13-14 below and also Actions / Plot Criterion Grid for more details.

8. If the model specification is changed, values are reset to defaults. To remove a variable or lag from the model temporarily, "fix" its parameter at zero. This preserves other stored values.

9. As a reminder that one or more parameters are fixed, the Values buttons in the corresponding dialogs are highlighted, and check-marks appear against the Values menu items.

PARAMETER BOUNDS

10. To constrain a parameter to lie in an interval, enter the upper and lower bounds in Values but do not check the 'Fixed' box. The reported parameter is then a logistic transformation of an underlying, unconstrained value. The bounds are ignored unless the upper strictly exceeds the lower. Cancel the setting by putting both bounds to 0.

11. If the estimate is in the interior of the interval, the standard error is approximated using the delta method. However, if the constraint binds in the sample, the covariance matrix may be near singular and standard errors unavailable or unreliable. It may be best to re-estimate with the parameter fixed at its boundary value, in this case.

12 It is not recommended to use this technique routinely to impose, e.g., positivity and stability constraints on lag polynomials. The search algorithm should usually work OK without this. The method is implemented more as a last resort for difficult cases.

GRID PLOTS

13. If bounds are set and the 'Fixed' box is also checked, the bounds will be used as the limits of a Grid Plot. Either one or two parameters can enter the grid. If the 'Fixed' box is checked and both bounds are 0, then the parameter in question is simply held fixed when the grid is drawn. If three or more parameter are both fixed and have bounds set, the first two encountered are the plotted parameters. The others are just treated as fixed in the usual way.

14. The number of grid points must be set in the Options / Optimization and Run dialog. The number is counted from zero. Thus, if the bounds are 0 and 1 and it is desired to evaluate at intervals of width 0.1, enter 10 in this text field. The likelihood will then be evaluated at 11 points, 0, 0.1,0.2,…,1.

WALD TESTS AND LINEAR RESTRICTIONS

15. To compute a Wald test of joint significance, enable "Wald Tests" in the Model / Linear Regression dialog, or "Parameter Constraints" in the Model / Dynamic Equation dialog. Then check the checkboxes of the variables to be included in the test.

16. If the option to test joint significance of the regressors is selected, these are included automatically, and do not need to be checked her. Any additional

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parameters checked here will be added to the test set.

17. To compute a Wald test of linear restrictions Rb = c, or impose these restrictions in estimation, the number of restrictions and the elements of c must first be entered in the Model \ Constraints dialog. Then, refresh the Values dialog and enter the columns of R' (i.e., the rows of R, transposed) in the fields displayed.

18. A restriction can involve any subset of model parameters, and hence can be spread over two or more number of Values dialogs. It may be helpful to open the relevant dialogs together and arrange them on the screen in a column. Restrictions may also be applied across equations and across regimes. Since only one equation/regime Values dialog can be displayed at a time, use the choice widgets or "Next..." buttons to switch quickly between them.

19. For each linear restriction, one parameter must be designated to be "solved" as a function of the remainder. Make this choice by checking the relevant "Constrained"/"Wald test" checkbox. There must be same number of checks in this column as restrictions, otherwise an error message is generated. It is also the user's responsibility to be sure that the restrictions can be solved uniquely for the checked parameters - in other words, the square submatrix of R' defined by the checked rows must be nonsingular. If this property does not hold, an error message is generated.

5.1 Values / Equation...

This dialog sets the parameters specified for an equation, including specifications set in either the Linear Equation dialog or the Dynamic Equation / Conditional Variance / Supplied Function dialogs.

Notes:

1. The Parameter Bounds / Grid Plotting checkbox affects all the Values dialogs. After changing the setting press "Refresh" to display/hide the text fields for entry of parameter bounds.

2. In multi-equation models, use the either the "Next Equation" button to cycle through the equations, or the "Equation" choice widget on the tool bar to switch directly. In regime-switching models, use the "Next Regime" or the "Regime" choice widget similarly, to see the different regimes.

3. If a BEKK multivariate GARCH model is specified, the ith columns of the matrices A_j and B_j are displayed in the dialog for equation i, as Alphaj(i,k) and Betaj(i,k), for k = 1,...,[number of equations]. Be careful to note how these matrices enter the model - see the main document for details. Although entered and reported in the same style, these matrices are not comparable with the multivariate GARCH specification. Be careful to interpret them correctly.

4. DCC dynamic parameters are displayed in the Values / Distribution dialog.

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5.2 Values / Equilibrium Relations...

This dialog shows parameters of the equilibrium relation(s).

Note:

1. If more than one relation is specified, use either the "Next Relation" button in the dialog, or the "Equation" choice widget on the tool bar, to switch between them.

2. At least one of the parameters in this dialog must be fixed at a non-zero value (the normalized variable). If none is specified manually, the first entry is automatically fixed at 1 when the equation is run.

5.3 Values / Distribution...

This dialog shows parameters defining the distribution that are not associated with any one equation in a multi-equation model. These are:

* the Student t parameters (degrees of freedom and skewness)
* parameter of the GED distribution
* parameter of the negative binomial distributions
* error correlations.
* Parameters of the DCC multivariate GARCH model

Notes:

1. In regime-switching models, use the "Next Regime" button to cycle through the regimes, or "Regimes" choice widget on the tool bar to select a regime directly.

2. Covariance parameters of the BEKK multivariate GARCH model, while not associated with any one equation, are nonetheless displayed in the Values \ Conditional Variance dialog. See Help page 5.2 for correct interpretation of these parameters.

5.4 Values / Switching Regimes...

This dialog displays parameters specified in the Model / Regime Switching dialog.

* In the Markov switching case (including Hamilton's model) these are the transition probabilities p_{ji} = P(j|i), forming a M´(M-1) matrix. These are the probabilities of switching from regime i to regime j.

* In the Explained Switching and Smooth Transition models, the dialog shows the parameters of these switching models.

Notes:

1. In the Markov case, the switching probabilities are constrained to be positive with their sum in [0,1], such that the implicitly defined Mth probabilities are nonnegative. These are transformed to unconstrained values t_{ji}for

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estimation using a logistic map. See the main document for the mapping formulae. These values are displayed in the output, with standard errors.

2. To show the t_{ji}values in the dialog, with upper and lower bounds transformed similarly when shown, check the "Display Logistic Transformations" checkbox.

3. By selecting the "Estimate Regime Differences" option, the Markov switching probabilities can (for example) be constrained not to depend on the current state. Under this hypothesis, the sample is simply a random mixture of regimes prevailing with the unconditional switch probabilities. Note that the null values of the "incremental probabilities" of regimes 2,...,M are 1/M, corresponding to t_{j2} = ... = t_{jM} = 0.

4. If regime-dependent coefficients are specified in Explained Switching, use the "Next Regime" button to cycle through the regimes, or the "Regime" choice widget on the toolbar to select a regime directly.

5. Note that specifying only the intercept and regime dummies in the explained switching model provides another way to estimate the simple Markov switching model, in an alternative parameterization.

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6. Actions

6.1 Actions / Run Estimation

Closes all dialogs, saves the current configuration in "settings.tsm", and starts estimation of the currently specified model.

To have the dialog box configuration restored automatically after the run is finished, select this option in General Options. Alternatively, re-open by hand with Actions / Restore Dialogs.

Notes:

1. This command can also be started with the "Run" button on the toolbar, and with the "Go" buttons in the Model / Linear Regression and Model / Dynamic Equation dialogs.

2. Sequential and iterative calculations can be interrupted while in progress, by clicking the "Run" button on the toolbar. A choice box appears, possibly after a short delay, with the option of aborting the run, or continuing.

BATCH JOBS

3. If the checkbox "Run Next Estimation as External Process" is checked in Options / Optimization and Run before the command is given, the run is performed externally by starting a new instance of Ox.

4. If the checkbox "Defer External Jobs" is checked in Options / General, the Ox file containing the job is created, but not run. Use this option if the job is to be run on a different machine, for example.

6.2 Actions / Evaluate at Current Values

This command is the same as Actions / Run Estimation except that the optimization algorithm is not called. The post-estimation output is simply created at the parameter values currently stored in the Values fields. Note that these are the estimates, following an estimation run. This option can be used, for example, to obtain test statistics, forecasts, listings etc. for a model that has just been estimated, without repeating the optimization.

Notes:

1. This command is also launched by the "Evaluate" button on the toolbar.

2. If Linear Regression or Cointegration Analysis dialogs are open, the command has the same effect as the 'Go' buttons and Actions / Run Estimation.

6.3 Actions / Estimate Multiple ARMA Models

Estimates a sequence of models with increasing ARMA orders, starting with ARMA(0,0). All other features of the model are as currently specified,

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although regime switching options are disabled. The limits of the sequence are set in the Setup/Multiple ARMA Models dialog.

Notes:

1. Starting values are set to either the estimates from the preceding specification, or zero, as appropriate. The ARFIMA(0,d,0) is initialized with Robinson's (1994) nonparametric estimator of d.

2. Other selected model features (regressors, conditional heteroscedasticity, supplied function) are estimated as usual, with the supplied starting values, for each case.

3. Post-estimation options (forecasts, correlograms, graphics, impulse responses, tests, series output and retrieval) are suspended. Re-estimate the selected model to get these outputs.

4. This option cannot be used in conjunction with regime switching, nor with multiple-equation models.

5. The model optimizing each of the selection criteria (Schwarz, Hannan-Quinn and Akaike) is reported following the run.

6.4 Actions / Automatic Regressor Selection

Given a baseline model containing N regressors of one or more Types (including current and lagged values of some variables, typically), this option estimates all the 2^N possible models formed by taking subsets of the full regressor set. It then reports the case which optimizes the chosen selection criterion, which can be either the Akaike (AIC), the Schwarz (SIC) or the Hannan-Quinn (HQC).

Notes:

1. Optional settings are selected in Setup / Automatic Model Selection (regressor Types), which also features an alternate launch button, and Options / Tests and Diagnostics (selection criterion).

2. The program excludes regressors from the baseline specification by turning their "Fixed" flags on, and setting the coefficient values to 0. In other words, the baseline specification is not actually changed during the run. To use the selected model for further work, it must be specified manually in the usual way. If the baseline specification includes regression parameters that are already "Fixed", this setting is retained and the variable in question is excluded from the search

3. The procedure optimizes exhaustively over the model space, looking at every case, and hence it is path independent and does not depend on test outcomes. Thus, it is not a "general to specific" search, nor "specific to general", but in fact both. The limitation is that it cannot feasibly examine such large model spaces some other automatic specification search packages that are currently available, which are

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selective in the cases they examine.

4. The procedure can be used with any model except regime switching, including equation systems, although it only searches over regressor choices. Any other model features will correspond to the baseline specification, and the search is conditional on these. Note that the number of models needing to be estimated may be very large. For example, with 4 variables and 4 lags (+ current values) N = 20 and the choice is over 2^20 = 1048576 cases. This is feasible for OLS, but probably not for iterative estimation.

5. There is no option to print all the estimation results. The output includes the baseline model, and the optimal case.

6.5 Actions / Recursive/Rolling Estimation

This option estimates the same model for a succession of samples, either of increasing size with fixed starting point (incremental estimation) or fixed size with moving starting point (rolling estimation). We call these procedures "recursive estimation", and while they are not recursive in the strict sense of using an updating formula to modify the estimator with the extra observation at each step, (it is computed afresh) the current estimates provide starting values for each new step.

See the Setup / Recursive/Rolling Estimation... dialog for details of setting up the run.

The sequence of results for each sample period can be exported to a file, according to the setting in Options / Output and Retrieval Options, or viewed as graphics. The items available are the parameter estimates with 2-standard error bands, plus (optionally) regression statistics including criterion values, residual moments, autocorrelation tests, stability (ex-post forecast) tests, and also any tests of parameter restrictions that have been set up.

Notes:

1. The sequential model selection criteria are not recorded. These would differ from the estimation criterion by the same fixed amount in each run, so the latter contains all the relevant information.

2 If N-step-ahead ex ante forecasting is specified (see Options / Forecasting and Simulation) the Nth forecast step and standard error (or percentiles for Monte Carlo forecasting) are reported in the output. By default, N is fixed so that the actual date forecast moves forward with the sample. There is an option to keep the terminal forecast date fixed, so that N contracts as the end of the sample advances. See Setup / Recursive/Rolling Estimation for details.

3. This command is launched by the "Run" button on the toolbar if the Setup / Recursive/Rolling Estimation dialog is open.

4. On checking the "Report Convergence Status" box, a sequence of symbols is printed in the results window to show the result of each numerical

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optimization.
+ denotes strong convergence of the search algorithm
? denotes weak convergence of the search algorithm
! denotes failure to converge
(See the Ox documentation for the definitions of these cases.)
This option has no effect in the case of non-iterative estimation.

6.6 Actions / Plot Criterion Grid

Use this option to create a contour plot of the concentrated criterion function. Parameter bounds must be enabled in the Values / Equation dialog. The number of grid points selected in Options / Optimization and Run.

The choice of parameters for plotting and the bounds of the grid are set in the appropriate Values dialog(s). The operation is carried out on the first one, or two, parameters satisfying the following conditions:
1. the "fixed" flag is set;
2. the upper bound exceeds the lower bound.

The criterion function is maximized with respect to all other parameters, holding the selected one(s) at the grid values. Normal output is suppressed. A progress bar shows the progress of the calculations.

A choice of contour plot and surface plot is available for the 3D case, set the option required in Options / Graphics. The "maximum maximorum" is indicated. The criterion values can also be exported in a table.

Notes:
1. Other parameters can be either fixed or free for this operation. If a pair of grid bounds for a fixed parameter are both set to zero, the parameter is treated as fixed, in the usual way.

2. Output to the results window includes the grid location of the criterion maximum, and also locations of the largest values of the test statistics, including absolute t ratios, diagnostic tests and any specified tests. This feature can be used to implement tests where parameters are unidentified under the null hypothesis. The usual procedure is to base a test on the supremum of the statistic over eligible values of the unidentified parameter(s).

6.7 Actions / Multi-Stage GMM

This command allows the computation of efficient GMM estimates, where the weights matrix is estimated to allow for heteroscedastic or autocorrelated errors. This is a two- or multi-stage procedure, performed by issuing this command repeatedly. Proceed as follows:

* Select the covariance formula required ('Robust' or 'HAC' in Options \ Tests and Diagnostics.)

* Select GMM as the estimator in Setup / Estimators and Sample.

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* Formulate the equation(s) in Model / Dynamic Equation.

* Select the instruments in Model / Select Instruments

* To compute the first-stage estimates (equivalent to regular IV/GMM) give the Actions / Multi-Stage GMM command.

* To compute the second-stage estimates, using the first-stage estimates to construct the required residuals, give the Actions / Multi-Stage GMM command a second time, before any other command.

* To iterate the procedure, repeat the last command as often as required.

Notes

1. Giving any other estimation command (for example, Actions / Run Estimation, or the "Run" button) resets the program, so that the next Actions / Multi-Stage GMM command yields Stage 1 again.

2. It may be possible to iterate the procedure to "convergence", so that no further change in the estimates occurs. However, this procedure does not optimize the GMM criterion function.

3. This option is not available for IV estimation from the Model / Linear Regression dialog.

6.8 Actions / Compute Test Statistic

Opens a sub-menu listing test options

* Score (LM) Test
* Moment (M or CM) Test
* Wald Test of Set Restrictions
* Specified Diagnostic Tests
* Bootstrap Test of I(0)

Notes

1. By default, the statistics printed by selecting these options are asymptotically Chi-squared with degrees of freedom indicated in parentheses. The nominal p-values of the tests are shown, enclosed in braces, following the statistic values.

2. The option of printing the "F form" of the tests, with associated p-values from the F tabulation, can be selected with the checkboxes in the relevant dialogs.
   Note: In most cases the F form is to provide an alternative approximation to the asymptotic Chi-squared distribution. These tests are exact only in special cases.

SCORE (LM) TEST

3. This option opens a dialog to allow specification of a test of the significance

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of additional regressors selected from the data set. Radio buttons allow selection of location of the test variables, either the Conditional Mean model (Equation (1), included as variables of Types 1, 2 or 3) or the Conditional Variance model (Equations (2)/(3), included as variables of Types 1, 2 or 3).

4. If the selected Type is assigned to include one or more lags (see Model / Dynamic Equation or Model / Linear Regression, and Model / Conditional Variance) then the same number of lags of the test variable(s) are included in the test set. It is not necessary for the null (estimated) model to contain lags. Just set the number of lags required (for the relevant Type) with the Lags scrollbar in Model / Conditional Mean or Model / Conditional Variance. The degrees of freedom of the test are 'number of test variables x (1+ number of lags)'. Select the "F form" of the test with the checkbox.

5. There are two ways to run the test. Pressing "Go" will execute it immediately using the currently stored parameter values. Otherwise, the test will be performed following the next estimation run. To cancel the test, press "Clear".

MOMENT (M or CM) TEST

6. This options opens a dialog to allow specification of a moment test of the correlation of variables selected from the data set with either
   * the model residuals, or
   * the squared model residuals.

7. If the Conditional Moment Test option is selected, the joint covariance matrix of scores and moments is computed using the Robust formula (see Options / Tests and Diagnostics). If the Moment Test option is selected, the selected HAC formula is used to compute this covariance matrix. This selection implies that serial correlation is permitted under the null hypothesis. Select the "F form" of the test with the checkbox.

6. Perform the test immediately with the current values by pressing "Go". Otherwise it will be performed following the next estimation run. Cancel it by pressing "Clear".

WALD TEST OF SET RESTRICTIONS

7. This option does not open a dialog, but simply computes the test of the constraints currently specified in Model / Constraints and the Values dialogs. The option allows new constraints to be tested on the current estimated model without re-estimation. If no constraints are specified, it does nothing.

SPECIFIED DIAGNOSTIC TESTS

8. This command evaluates the optional tests that have been specified in the Options / Tests and Diagnostics dialog. These are computed automatically following an estimation or evaluation run, but this method allows additional tests to be computed without generating the complete estimation outputs.

TEST FOR I(0) DEPENDENT VARIABLE

9. This option simulates the model currently stored and computes Breitung's (2002) statistic for the partial sums. The reported Kolmogorov-Smirnov

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statistic compares the bootstrap distribution of this statistic with the same statistic computed for the corresponding i.i.d. shocks. Its object is to check whether the model dynamics are compatible with sample averages adequately approximating their asymptotic distributions, in the selected sample size.

10. The I(0) test is for single equation models only, and is properly intended for use with univariate time series models. If the equation contains exogenous variables, these are held conditionally fixed in the simulations. If they are nonstationary, this will in general yield a case of the alternative hypothesis.

11. Choose a number of replications large enough to validate the asymptotic tables from Smirnov (1948) - say 500. Set the number of replications in Options / Simulation and Resampling, after checking the "Inference by Resampling" checkbox to activate the replications scrollbar.
NOTE: This checkbox does not activate the test itself. It can be unchecked again after the setting is made.

6.9 Actions / Compute Forecasts

This command generates and displays forecasts after a model has been estimated. Note that, if forecasts are specified prior to an estimation run, they are computed automatically following the run. This option allows additional results to be generated.

Note: The command Evaluate at Current Values ("Calculator" button) is another way to compute specified forecasts, in addition to any specified tests. The complete output for the run is printed in the results window in this case. This command does not produce any additional output, and displays the forecast plots automatically.

6.10 Actions / Retrieve Series

This command adds items such as residuals, fitted values, conditional variances, switch probabilities and other generated series to the data set. To use it, first open the Options / Output and Retrieval dialog and check the items to be retrieved.

Notes:

1. A fitted model must be present in memory when the command is given, or else it has no effect. Either an estimation run has previously been performed, or a previously stored model has been loaded using the Model Manager.

2. When the Retrieve command is given, the checks in the Options / Output and Retrieval dialog are removed so that the same items are not saved twice.

3. Items can be retrieved automatically following a run by checking them in the Options dialog before launching the run. Choose from the "Once" and "Always" options in this case. The former removes the checks after saving.

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6.11 Actions / Simulate Current Model

This selection generates and displays a stochastic simulation of the current model. The user is prompted to choose to discard the series after viewing or write to the data set and, in the latter case, to either add the series as new variable(s), or over-write the existing dependent variable(s).

Notes:

1. To select the mechanism generating the artificial shocks, see Options / Simulation and Resampling Options. The choices are Gaussian, model (according to likelihood function adopted) and a bootstrap of the current model residuals.

2. Create model for simulation in one of three ways: estimate a model, retrieve a stored model, or type parameter values direct into the Values dialogs.

3. A dependent variable (or variables) must be selected to act as a 'placeholder', and provide any start-up values. This can be a dummy such as "Zeros" (see the 'Make Zeros' option in Setup / Data Transformations and Editing). In this case all pre-sample lags would be set to zero, but chosen presample values could be entered using the 'Edit' command in Setup / Data Transformations and Editing.

4. To bypass the discard/save prompts, assign this command to one of the two user-selectable toolbar buttons (see Options / General). When the button is pressed most recent choices are applied automatically. Use the menu command to change them.

5. To simulate without a data set loaded, first use the 'Extend Sample' option in Setup / Data Transformations and Editing to specify the sample size required Then create a placeholder variable using 'Make Zeros'.

6. If estimation is by least squares or GMM, the residual variance is not in the parameter set, and is estimated extraneously from the residuals. If simulation follows estimation, the current estimate is used. To specify a model for simulation without prior estimation, select one of the conditional maximum likelihood (time domain) estimators. This will allow all the model parameters, including the error variance, to be entered in the Values dialogs.

6.12 Other Commands

SET DEFAULT VALUES

This command sets all free parameter values to defaults. Fixed values, and all fixes, bounds and constraint settings, are retained.

CLEAR VALUES

This command has the same effect as pressing the Clear button in all the Values dialogs. Parameter values are set to defaults, and all fixes (except defaults), bounds, and constraints are removed.

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CLEAR RESULTS WINDOW

If the results buffer becomes full and will accept no more text, use this command to clear it. Note that its contents can first be first saved to a file, see File / Results / Save Selected Text.

CLOSE ALL DIALOGS

This command is given automatically before estimation operations are carried out. Current window positions are stored.

RESTORE DIALOGS

Reverses the action of Close All Dialogs. Use it after an estimation run, and also after starting the program, to restore the previous window configuration. This action can optionally be made automatic, see Options / General Options.

Notes:

1. The actions of Close All Dialogs and Restore Dialogs are duplicated by the toolbar "Windows" button, which toggles between them.

2. Dialog positions for open dialogs are saved between runs. Restore Dialogs (or the "Windows" button) restores your dialog configuration at shut-down.

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7. Graphics

7.0 Graphics: General Information

Graphics are displayed in a window whose size is linked to screen resolution. As many graphs as desired can be open at once. Close them by clicking the "Close" button in the top-right hand corner, or from the Windows taskbar.

* Clicking on the "gnuplot" icon in the top-left corner of the window opens a context menu. Choose "Options" to open a submenu of useful commands. These include changing the text font, line style and background colour, sending to a printer, and copying the graph to the Windows clipboard, so that the image can be pasted into your favorite graphics program.

* For bitmaps, IrfanView is a highly recommended freeware package, which can convert an imported image to a variety of bitmap formats such as .jpg. Note that the gnuplot window can be resized by dragging the corner with the mouse, and a saved bitmap image will have the same dimensions. Alternatively, pasting the clipboard into a graphics program such as CorelDraw results in a vector graphics image that can be edited further, and saved in various formats.

* An alternative procedure to save a graph is with the command File / Graphics / Save Last Graphic. The type of file saved, and bitmap dimensions, can be selected in the Options / Graphics dialog. Note that line styles and fonts cannot be selected within the program in this case. However, the Postscript vector graphics formats (.eps or .epc) can be imported into graphics programs such as CorelDraw for further editing.

7.1 Graphics / Show Data Graphic

Opens a dialog for selection of graphical representations (time plot, correlogram, spectrum, histogram and normal QQ-plot) of any variable in the data set.

SIMPLE PLOTTING

* Select the type(s) of plot required, using the check boxes.

* Select one or more names in the variable list.

* Optionally select for the series to be either detrended by OLS, or differenced, before plotting.

* Press "Sample ..." to open the Set Sample dialog and choose the sample required.

* Press 'Go'. Alternatively, just double-click the name of any series (convenient for a single plot).

Notes:

1. Unselect a selected variable by clicking it second time. Press 'Clear' to

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unselect all selected variables.

2. Double-clicking a variable on the list just displays the plot. Selecting with a single click and then pressing 'Go' plots the variable(s) and leaves them selected.

3. Up to 36 plots can be displayed on one page. However, with large numbers of plots the quality of the display is not too good .

4. If only time-plots are selected, multiple plots can appear in one graph by selecting this option in Options / Graphics (see Multiple Series Display). However, if correlograms or other types of plot are selected, plots appear in their own graphs in a common frame.

5. If the Scatter Plot option is selected, the first two highlighted variables in the list are plotted together - the first on the list is assigned the vertical axis, (Y) and the second the horizontal axis (X) Reverse the ordering if desired in Setup / Data Transformation and Editing / Edit / Move Up-Move Down. If only one variable is highlighted, nothing is plotted. Other options can be selected at the same time, and will be displayed for all highlighted variables.

6. In a scatter plot, the two regression lines (Y on X and X on Y) are superimposed by default. Note that these both pass through, and therefore jointly indicate, the point of sample means. The more nearly parallel these are, the higher the correlation between the variables. Unselect this feature in Options / Graphics.

7. The sample selected for plotting (Sample 5) is independent of the samples set concurrently for other program functions. See Setup / Set Sample for details. If data are missing for part of the specified period, nothing is plotted for these observations.

MULTI_SERIES PLOTTING

This option allows up to 8 series to be plotted on one graph, with line styles selected by the user. This option gives the user more control over plotting styles than is available with simple plotting.

* Check the "Multi-Series Plot" Checkbox.

* Choose a line style (1-8) using the radio buttons, and then a variable from the list - at most one variable can be selected for each style.

* Repeat for up to 8 series.

* Press 'Go'.

Notes:

7. Multiple series plotting only works for time plots. Other types of plot are shown in the usual way, in separate graphs in a common frame. Line styles only apply to time plots.

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8. This option over-rides the Multiple Series Display setting in Options / Graphics.

9. Line styles can be edited in Options / Graphics.

10. The 'Scale on Right Axis' checkbox is enabled when two or more series are selected. If checked, the series with the largest line number is plotted against the right-hand axis. If more than two series are selected, all the others are plotted against the left-hand axis as usual.

11. The 'Centre' and 'Standardize' checkboxes allow the variables to be relocated and rescaled for comparability. Centre subtracts the mean, and Standardize also divides by the standard deviation.

12. If the line type for Line 8 is chosen as 'Band Fill', the selected variable is used to divide the sample into 'regimes'. If the selected variable is positive the regime is "On", and if the selected variable is zero or negative the regime is "Off". The observations of the "On" regime are indicated by light gray shading in the plot. Typically, the indicator variable would be a zero-one dummy.
NOTE: Only Line 8 can be given the Band Fill style.

7.2 Graphics / Equation Graphics

The following items can be plotted following an estimation run:

* 'Actual and fitted' series (submenu, time and scatter plots)
* Residuals (sub-menu)
* Variance-adjusted residuals (sub-menu)
* Conditional variances (GARCH and regime switching models only)
* Regime probabilities (sub-menu, regime switching models only)
* All the time plots for the model in one frame.
* Equilibrium relations (sub-menu, error correction models only)
* Ex ante forecasts (sub-menu)
* Solved moving average coefficients, impulse response and step response (submenu)
* A 2D or 3D plot of the criterion function if computed, see Actions / Plot Criterion Grid.
* Plots of the recursive or rolling estimations, if computed (dialog)
* Kernel density plots of the bootstrap distributions of parameter estimates and test statistics.

Notes:

1. In the Residuals, Adjusted Residuals and Equilibrium Relations submenus, the available options are time plot, correlogram, spectrum, correlogram and spectrum of absolute values, histogram and kernel density, and normal QQ-plot. There is an option to display all the representations in the same frame.

2. The Actual vs. Fitted scatter plot includes the "Fitted vs. Fitted" line, which has slope 1 by construction and passes through the point of sample means. The residuals correspond to the vertical deviations around this line, but

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ordered by magnitude of the fitted values instead of the sample time ordering.

3. Regime probabilities are summed over lags in Hamilton's switching model. Smoothed regime probabilities are computed by Kim's algorithm, see Kim and Nelson (1999), pp68-70. When switching probabilities are explained by exogenous variables, both filter probabilities and the variable transition probabilities can be plotted. For smooth transition models, the transition function can be plotted.

4. Forecasts and solved MA weights can be computed for the equation and the conditional variance, where this is estimated.

5. The interpretation of ex-ante forecast time plots depends on the forecasting method. With analytic forecasting, the plots show the estimated mean forecast, with optional 2-standard error bands. Standard errors are not available for bilinear models and user-supplied dynamic models, nor for conditional variance forecasts in GARCH models.

6. Monte Carlo forecasting generates the distribution of stochastic simulations, and the plots show the median forecast and the 2.5% and 97.5% percentiles. These therefore define a true 95% confidence band, regardless of the error distribution, and are available for all models, and for conditional variances. Kernel density plots of the empirical forecast distributions are also available for any point in the forecast period (selected in Options / Forecast and Simulation Options).

7. To change the type or number of forecasts, make the desired selection in the Options / Forecast and Simulation dialog, then recompute the model, using either Actions / Run Estimation, or Actions / Evaluate at Current Values to avoid re-estimating.

8. To view a plot of the recursive/rolling estimations, either double-click a parameter/statistic in the list, or select it and press "Go". The rolling parameter estimates are displayed with 2-standard error bands (the usual regression standard errors, with covariance matrix formula selected in Options / Tests and Diagnostics.)

9. The 'Fill' symbol option is used for probability and variance plots. That is, the region between the plotted line and the time axis is shaded light gray. If for any reason a different plot style is required for these series, use the "Retrieve Series" command to add them to the data set, then plot using the options in Graphics / Show Data Graphic.

10. Select the type of plot desired for confidence and standard error bands in forecasts and recursive/rolling estimation (none, bands or bars) in Options / Graphics Options.

7.3 Graphics / Monte Carlo Graphics

The frequency distributions generated by Monte Carlo experiments can be

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displayed as kernel densities and histograms. Cumulative frequencies can also be displayed as an option.

* Select plots for display by clicking on the list, or pressing 'Select All'. Unselect an item by clicking again. Remove all selections with 'Clear'. Plot selected items by pressing 'Plot'.

* Double-clicking a list item displays the plot, but does not leave the item highlighted.

1. The graphic display dialog opens automatically at the completion of a Monte Carlo run. Alternatively, open it from the menu with Graphics / Monte Carlo Distributions...

2. The bandwidth used to compute the kernel density is user-selectable. Initially it is set to the default value, displayed as '1' on the scrollbar. Move the scrollbar to change the ratio of the bandwidth to the default, then redisplay the plot to see the effect. The chosen value is stored with the distribution data and used the next time the distribution is plotted, as shown by the scrollbar.

3. If the scrollbar setting is changed by the user, the new value is used for the next plot, and replaces the stored value(s) for the distribution(s) plotted.
   Tip: to avoid changing a stored bandwidth after moving the scrollbar, close and re-open the dialog before giving the Plot command.

4. Monte Carlo graphics are stored in the .TSD file created with the Data Generation Model. If the .TSD file is present, reloading this model makes the results and plots of the last experiment performed with this model available to view, just as when the model was run. To save these outputs, store the DGM under a different name, before using it for a new experiment.

5. The distributions from a simulation run can be stored in an EDF file to supply critical values for tests. The currently stored bandwidths for each distribution are used to compute the EDF kernel densities.

   Note: EDF file creation can also be done automatically, using the default bandwidth, by setting the requisite option in Setup / Monte Carlo Experiment. The present option can be used to fine-tune the bandwidths used for each distribution, if required.

6. Monte Carlo graphics can be stored and displayed independently of the DGM that produced them. This allows the results of different runs to be plotted together for comparison.
   * Highlight the plots to be stored.
   * Click on "Add to Store".
   * In the text box that opens, the current name is displayed. Edit or replace this name to identify the plot in a comparison of DGMs.
   * Click "OK", or press the Return key, to close the text box.
   * Repeat the naming procedure for each plot selected.

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Note: The stored plots are saved in the settings file, not in the .TSD file associated with a model.

7. To display the stored plots, select Graphics / Stored MC Distributions ... from the menu.
   * Select and display plots as usual
   * Highlight a name and click "Rename" to re-open the text box and type a new name.
     Note: Only one plot at a time can be renamed.
   * Highlight any number of names and click "Remove" to remove the graphics from the store.
   * Highlight one name and click "Move Up" or "Move Dn" to change the order in which plots are displayed

   Note: The bandwidths for stored plots can be changed in the same way as described in 3.

8. To show two or more density plots in the same graph for comparison select the Options / Graphics from the menu and then "One Graph" in Multiple Series Display. The MoveUp/Dn buttons allow control over the colours or line types used to display each plot, also the order in which legends appear.

   Note: Histograms are not displayed for two or more densities in the same graph, even if this option is selected.

9. The saved plots can be exported to a spreadsheet file, for subsequent reloading and/or merging with those stored in a different settings file. Pressing the "Save Plot Data" button opens the file dialog for saving.

   Notes:
   * Reload plots with the command File / Data / Load Tabulations / Density Plot File.
   * The spreadsheet format is as follows:
     Row 1: Plot names.
     Row 2: Kernel bandwidth index (integer 0-32)
     Row 3: Initial bin ordinate.
     Row 4. Increment (bin width).
     Rows 5,.... Histogram values.

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8. Options

8.0 Options: General Information and Defaults

By default, only one Options dialog is open at a time. Opening a second dialog causes the first to close. This behaviour is optional, see General Options.

The <<< and >>> buttons at the top of each window allow easy navigation between the options dialogs. Pressing them opens the next/previous options dialog, so that current program settings can be reviewed rapidly.

DEFAULTS
The default settings are as follows. These are selected if the file "settings.tsm" is not found in the working directory at start-up, or on the command File / Settings / New. "*" in the left-hand column indicates that this setting is stored with a model, and hence is liable be changed when a model is loaded.

Output and Retrieval Options:

	Save Data to Files of Type . . .	XLS
	Export Listings to Files of Type . .	None
	Save Listings Automatically. . . .	No
	Print in Results Window . . .	Correlograms
	Retrieve Generated Series . . .	Once

Test and Diagnostics

*	Q Test Order	12
*	Q-Test Type	Box-Pierce
*	LM Tests	No
*	Durbin Watson Test	No
*	Diagnostic Tests	None
*	Covariance Matrix Formula . . .	Robust
*	Kernel for HAC Covariances . . .	Parzen
*	Bandwidth for HAC Covariances . .	[n^(1/3)] for Bartlett,
	. . .	[n^(1/5)] otherwise.
*	Show Residual Moments . . .	Yes
*	Show Log-Likelihood & Criteria . .	Yes
*	Tests in R^2 Form	No
*	Use EDFs	No

Forecasting Options

*	Forecast Type.	Ex Ante Multi-step
*	Forecast Method	Analytic
*	# Actuals in Forecast Plot . . .	50
*	# Monte Carlo replications . . .	1000
*	Compute Confidence Bands . . .	Yes
*	Impulse Responses	Impulse

Simulation and Resampling Options

*	Shock Distribution	Gaussian

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*	Random Number Seed . . .	0 (system clock)
*	Shock Variance (Gaussian) . . .	1
*	Presample Data	Fixed
*	type I fractional . . .	No
*	Use Likelihood Model . .	Yes
*	Enable Bootstrap Inference . . .	No
	Once/Always	Once
*	Confidence Intervals	Equal Tails
*	Bootstrap Replications . .	99
*	Fast Double Bootstrap . .	No
*	Bias Correction . . .	No
*	Newton-Raphson algorithm . . .	No
*	Maximum Iterations	50

Graphics Options:

Export Graphs to Files of Type . .	.PNG
Save Graphs Automatically . . .	No
Display plots using GnuPlot . . .	Yes
Dates Format	YYYY
PNG Image Size	640x480
2SE Band Style for Forecasts . . .	Bands
Multiple Series Display . . .	One Frame
Time Series Plot Type. . . .	Lines
Criterion 3D Plot Type . . .	Both
Density Options:	
Histogram	Yes
Normal Curve	No
CDF	.No
Colour/Monochrome . . .	Colour
Keep PLT files . . .	No
Extended Actual-Fitted . .	No
'Fill' Probs and Var plots . . .	Yes
Line Width	1
Symbol Size	1

ML and Dynamic Options:

	Maximum ARMA/GARCH Order . .	10
*	MA Polynomial with '+'s . . .	No
*	Root of Student t d.f.	2
*	Log of Skewness Parameter . . .	Yes
*	Restrict Pre-Sample Lags . . .	No
*	GARCH coefficients in Standard Form .	No
*	Type 2 GARCH intercept . . .	No
*	Root of GARCH Intercept . . .	2
*	No. Gauss-Seidel Its in GARCH-M . .	5
*	GARCH-M Trimming Factor . . .	10
*	Compute EGARCH Likelihood by G-S .	No
*	No. G-S Its. to compute EGARCH . .	50

Optimization and Run Options:

*	Report Minimand	No

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	No. Grid Points for Criterion Plot . .	10
*	Absolute bound on dynamic params. . .	3
*	Max No. of BFGS Iterations . .	-1 = Ox Default
	Iteration Print Frequency . . .	0
*	Strong Convergence Crit. . . .	-1 = Ox Default
*	Weak Convergence Crit. . . .	-1 = Ox Default
*	Parameter Rescaling Factor . . .	0 (= off).
*	Simulated Annealing . . .	Yes
*	# SA Iterations . . .	500
*	Initial Temperature	5
*	Temperature Reduction Factor . .	0.85
*	# Iterations before Temp. Reduction . .	10

General Options:

Restore Dialogs Automatically . .	No
Enable Savings Prompts . . .	Yes
Store Model After Each Run . . .	No
Delete Temporary Files on Exit . .	No
Automatically Close Options Dialogs .	Yes
Size of Results Window Text . . .	12 points
Echo Results to Console . . .	No
Show Tool Tips	Yes
Enable Error Recovery . .	Yes
Drag-Selection . . .	Yes
Enable Optimization Estimators .	Yes

8.1 Options / Output and Retrievals ...

SAVING DATA FILES

1. The type of data file saved (.XLS, .CSV, .WKS, .IN7, .DAT or .MAT) is determined by the extension added to the file name. If no extension is added by the user, the one selected in this dialog is included automatically. However, note that the user's choice over-rides the selection in this dialog. For example, if the name is selected from the list of existing files in the file dialog, with extension .XLS, the selection here is ignored, if different.

OUTPUTTING TABLES AND SERIES

2. The following series can be either printed in the results window, or exported to a file.
   * The actual data series, Y_t.
   * The fitted series Yhat_t, followed by the ex post 1-step forecasts, if specified.
   * The residuals Y_t - Yhat_t (solving equation (1) for u_t at the estimated parameters) followed by ex post 1-step forecast errors, if specified.

   If conditional heteroscedasticity options are selected, also
   * The variance-adjusted residuals , followed by ex post 1-step adjusted forecast errors, if specified.
   * The estimated conditional variances, followed by ex post 1-step variance forecasts, if specified.

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If a smooth transition model specified, also the transition weights.
If Markov-switching regimes are specified, also

* The filter probabilities
* The smoothed probabilities
* For explained switching models, the transition probabilities for Regimes 1 to M-1.

In regime-switching models the residuals are computed as weighted averages of the regimes, using the filter probabilities as weights.

Note: In the case of the Probit model, generalized residuals replace variance-adjusted residuals.

EXPORTING AND PRINTING LISTINGS

3. The Export Listings option controls the export of the items listed under 2. Select a radio button for the type of spreadsheet file or ASCII file to save. The files are identified by a descriptive name and the current run ID.

4. Check the checkbox "Save Listings Automatically" to have all the series associated with an estimation run saved to a file of the selected type. If this box is not checked, specific outputs from the latest run can be saved individually as required, by selecting the menu items under File / Listings /.

5. To distinguish sample and ex-post forecast periods in the output file, an extra column is printed with an indicator variable, 0 = sample, 1 = forecast.

6. Check the boxes in "Print to Results Window" to have the items appear on the screen. Large screen listings are best avoided, since the results window buffer may fill up rapidly.

RETRIEVING GENERATED SERIES

7. "Retrieving" series means adding them to the current data set for further analysis in the program. The radio buttons allow you to choose whether to retrieve the next run only, and then cancel the option, or keep it selected. The series are allocated standard names, with numbers appended to distinguish successive retrievals. They can be renamed more descriptively in the Data Transformations dialog, if desired.

8.2 Options / Tests and Diagnostics ...

1. Unless otherwise indicated, the test statistics controlled through this dialog are by default asymptotically Chi-squared with degrees of freedom shown in parentheses. The nominal p-values of the tests are shown, enclosed in braces, following the statistic values. F-versions of the tests can be optionally substituted.

Q TESTS FOR SERIAL DEPENDENCE

2. Q tests for autocorrelation in levels and squares are printed after every estimation run. The upper limits to the Q test order and correlogram order are set at (number of observations)/3. In models where variance-adjusted residuals are defined (GARCH, regime switching), the Q

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statistics are computed for these series.

3. Check the 'Ljung-Box' radio button to use the Ljung-Box (1978) formula for the Q statistic, otherwise, the Box-Pierce (1970) formula (the default).

DIAGNOSTIC TESTS

4. Preset diagnostic tests are available in score test and conditional moment test versions. The option of printing the "F forms" of the diagnostic tests can be selected with the check box. This provides an alternative approximation to the asymptotic Chi Squared distribution. Note that these tests are not exact except in special cases.

SCORE (LM) TESTS

5. The following pre-set score tests are available. In each case, the score of the extended model at the null parameter values is tested. The extensions are:
   * Autocorrelation: lagged residuals in equation (1).
   * Neglected ARCH: lagged squared residuals in equation (2), or absolute normalized residuals in equation (3), if EGARCH is specified.
   * Nonlinear Functional Form (RESET): Integer powers of the fitted values of the null model in equation (1).
   * Heteroscedasticity: square of the fitted values in equations (2)/(3).
   * AR common factors: p lags of Type 1 regressors in a model with AR(p) errors specified.

   The number of lags to be included, and the order of polynomial in the fitted values, can be selected with the scroll bars. These statistics are indicated in the output by "(LM)" after the description.

6. If no conditional variance is specified in the null model, the LM tests for neglected ARCH and heteroscedasticity is performed by regressing squared residuals on lagged squared residuals or the squared fitted value, respectively. Otherwise, the test variable(s) are added to the conditional variance model as regressors.

7. The test variables are designated regressors of Type 3 if a MA (GMA) component is selected, and of Type 2 if a AR or FI (GAR or FIGARCH) component is selected, and otherwise of Type 1.
   NOTE: test variables cannot be assigned to a Type for which lags are already selected. If lags are specified for Type 1 variables, the test may be unavailable. A warning message is printed in this event.

8. The AR common factor test is enabled in the following case: a model with Type 1 regressors, current values only; no Type 2 regressors; and an AR(p) error process is specified, but not a fractional process. The null hypothesis is that p lags of the regressors are not independently significant, in other words that there are common AR factors shared by the dependent variable and regressors in the model, so that AR errors are valid representation of the dynamics.

9. The 'T.R^2 form' option gives a choice of small sample approximations for diagnostic LM tests on the mean model. The default is to report the

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statistic W/(1 - W/T), where W is the usual LM statistic, and T is the sample size. If W takes the usual form of TR^2 in the artificial regression of the residuals on the gradients under H0, the default is therefore TR^2/(1 - R^2). (In a linear model, this is equivalent to normalizing the statistic with the unrestricted residual variance under the alternative.) Note that the asymptotic distributions are the same under H0. Select the option to report W itself. When the 'F-form' of the statistic is selected, this option is unavailable.

CONDITIONAL MOMENT (CM) TESTS

10. Five conditional moment tests are pre-set. The hypotheses under test are the following.
    * Autocorrelation: correlation between current and lagged normalized residuals.
    * Neglected ARCH: correlation between current and lagged squared residuals.
    * Nonlinear Functional Form: correlation between the normalized residuals and integer powers of the fitted values.
    * Heteroscedasticity: correlation between the squared normalized residuals and the squared fitted values.
    * Test for AR common factors: correlation between the normalized residuals and lags of the Type 1 explanatory variables. (see para. 9 above).
    * Information Matrix Test: expected value of the difference between the information matrix and outer product of the score.

11. Note that in GARCH-type models, CM tests use the normalized (variance-adjusted) residuals as the test covariates. In tests for neglected ARCH, at least fourth-order moments must exist, and failure of this assumption can invalidate test results - caution is advised when interpreting the findings.

12. CM diagnostic tests are always computed with the joint covariance matrix of scores and moments computed by the robust method (see 12. below). Moment tests can also be specified using one of the HAC estimators, see Actions / Compute Test Statistics / Moment Tests.

13. The CM and LM tests are unavailable for use with the Whittle estimator. The information matrix test is also unavailable with the least squares and GMM options, since the derivation of this test assumes the criterion function is a log-likelihood.

OTHER DIAGNOSTIC TESTS

14. The Information Matrix test is available only for estimation by Maximum Likelihood. It compares the inverted information matrix with the robust covariance matrix estimator, having k(k+1)/2 degrees of freedom when k parameters are estimated. This can be used as a guide to correct model specification, and can also indicate best choice of covariance matrix formula.

15. The Nyblom-Hansen model stability test is available as a whole-model test (degrees of freedom equal to the number of fitted parameters, including residual variance) and, optionally, as one-degree-of-freedom tests for

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individual the parameters. Check the "Indiv." checkbox for the latter option. These are not printed by default since the output is potentially bulky. Note that the tests use the table given in Hansen (1990), and the p-values are available in inequality form.

16. The Durbin Watson test is included only for heritage reasons. It is asymptotically equivalent to the Box-Pierce Q statistic for 1 lag. The LM or CM tests for residual autocorrelation are recommended in a regression context.

17. Use the 'Coded Test' checkbox to activate/deactivate a test statistic that has been supplied by the user as Ox code (see Appendix C). This checkbox has the same function as the 'Test' checkbox in the Model / Coded Function dialog. It is disabled unless code is loaded and the 'Test Only' option is selected in Model / Coded Function. In the case where other Ox code is being compiled, this test option should be controlled from the same dialog.

18. The KPSS, RS and HML tests are alternative tests that the residuals are I(0). These are also available for data series from the Setup / Summary Statistics dialog, and may be useful in conjunction with the ADF and PP tests in the context of cointegrating regression. For the truncation parameter c and bandwidth parameter L, use the default values or see Harris et. al (2006) for guidance.

BOOTSTRAP TEST OF I(0)

19. Check this checkbox to run the test following an estimation run. This test can also launched from the Actions / Compute Test Statistics menu. For further details see Section 6.8 of the Users's Manual.
NOTE: Bootstrap inference for the equation itself is disabled if this option is selected.

COVARIANCE MATRIX FORMULAE

20. Four methods of calculation are available for computing covariance matrices:
    * 'Standard' corresponds to the information matrix in ML estimators, and is generally appropriate for correctly specified models with iid errors.
    * 'Robust' allows for mis-specified likelihoods and heteroscedastic but independent errors.
    * 'HAC' is for models with residual autocorrelation as well as possible heteroscedasticity.
    * 'KVB' selects the inconsistent estimator proposed by Kiefer, Vogelsang and Bunzel (2000).

21. The method selected here is used for equation standard errors and also Wald and LM tests. M statistics use HAC, and nonparametric tests of I(0) (see Actions / Compute Summary Statistics) use HAC. Whittle estimates use HAC if KVB is selected.

22. The KVB estimates correspond to HAC using the Bartlett kernel and bandwidth equal to sample size. Note that they are inconsistent, but yield

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asymptotically pivotal tests based on a nonstandard distribution. P-value inequalities are reported from the published tables, and are identified in the output with the @ symbol .

23. KVB can be implemented for nonlinear models and GMM at the user's discretion, but take care to note that asymptotic distribution results for these cases are not available to date. See the citations in the main document for further details.

HAC KERNEL FORMULAE AND BANDWIDTH

24. The kernel formula selected here is used when the HAC covariance matrix is selected. It also determines the choice for Phillips-Perron, KPSS and RS tests, and Fully Modified Least Squares estimation. It does not effect the kernels used in density plotting and nonparametric regression, which are Ox defaults and cannot be changed by the user.

25. There are three options for selecting the HAC bandwidth
    * Manual selection using the scroll bar
    * The automatic 'plug-in' method due to Andrews (1991)
    * The automatic 'plug-in' method of Newey and West (1994).

26. Check the 'Prewhitening' checkbox to prewhiten the data by a VAR(1) regression, prior to computing the HAC covariance matrix, V.
    V then is 'recoloured' as DVD' where D = (I - A)^(-1) and A is the VAR coefficient matrix.
    NOTE: Use prewhitening with caution! It may inappropriate, e.g., in construction of test statistics for I(0) by overcompensating under the alternative.

27. The plug-in bandwidths are set as the minimum of the value returned by the formula and (sample size)/2. Larger bandwidths can be set manually.

MODEL SELECTION CRITERIA

28. A model selection criterion is needed for three automated model selection features.
    * Automatic regressor selection (see the Actions menu and Setup / Automatic Model Selection).
    * Lag selection in the augmented Dickey Fuller test.
    * Lag selection in the Stock-Watson/Saikkonen augmented least squares estimator for cointegrating relations.

    The radio buttons allow a choice of the Akaike, Schwarz and Hannan-Quinn criteria for these purposes.

LM TESTS OF RESTRICTIONS AND "FIXED" VALUES

29. Check the 'LM Tests of Parameter Restrictions' box to compute the score (LM) statistic for restrictions imposed on the parameters in the "Values" dialogs. There are two modes of operation of this option. If parameter constraints have been activated in the Parameter Constraints dialog, these restrictions only are tested. If parameter constraints are not set, but parameters have been fixed in the Values dialogs, a test of the fixing restrictions is generated. This scheme allows testing of one set of restrictions

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while simultaneously including others in the maintained hypothesis. NOTE: This option is not available for linear regressions. Use Wald tests to test restrictions in this context.

SUPPLYING AN EDF FILE FOR P-VALUES

30. Check the box "Use EDF from File for p-Values" if tabulations of test distributions has been created by Monte Carlo simulation of the null hypothesis. The currently loaded EDF file is used to supply p-values for each test for which a tabulation exists in the file. In the case of significance tests (t-tests) the parameter's name must match a name in the file.
    Notes:
    1) P-values taken from the EDF are marked with a '$' in the output.
    2) See Setup / Monte Carlo Experiments for details of the EDF file format.
    3) EDF files can be read and plotted in Setup / Look Up Tail Probability and Setup / Look Up Critical Value. To read off a p-value, type the test statistic into the first 'Tail Probability' dialog.
    4) EDF files are spreadsheet files, recommended format is '.xls'. They can be loaded as data files, inspected and merged in TSM.

31. If tabulations for several sample sizes are created, these can be merged into a single EDF file. Use the command File / Data / Tabulations / Merge EDF File to merge a file on disk with the one resident in memory. These tabulations will be used to calculate p-values by interpolation.
    For example, suppose tabulations for T = 50, 100, 200 and 500 observations have been created and merged. If the actual T is 150, a weighted average of the tabulated p-values is returned, with weight
    w = ((200 - 150)/(200 - 100))^2 = 0.25
    on the case T = 100, and 1 - w = 0.64 on the case T = 200 (i.e., greater weight on the larger sample size than with a linear interpolation). If T exceeds the largest tabulated sample size or is less than the smallest, then the nearest values are used with weight 1.

8.3 Options / Forecasting ...

FORECASTS

1. The levels forecasts include 2-standard error bands. These are asymptotic and do not allow for parameter uncertainty. For conditional heteroscedasticity models, they are computed dynamically using the volatility forecasts.

2. The scroll bar label shows the number of forecast steps selected. The date or observation number of the final step, which depends on the sample selection (see Setup / Set Sample) is shown above the scroll bar.

3. There is no limit to the number of ex-ante forecasts. To increase the maximum, select it, then close and re-open the dialog. However, in models containing exogenous variables (other than the trend and GARCH_M terms)

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the limit is set by the available post-sample observations.

FORECAST TYPE

4. "Ex ante" multi-step forecasts use the lagged forecast values to projected two or more steps forward. "Ex Post" 1-step forecasts are simply the fitted values of the model (using actual values of all lagged and explanatory variables) for the selected forecast period. This cannot exceed the available observations, so the estimation sample must be set appropriately.

5. By default, the forecast period for ex-post forecasts is set to the maximum available observations following the 'Last Observation' set in the Setup / Set Sample dialog. If this setting is changed, the number of forecasts is adjusted to the default. To include fewer than the maximum number of observations in the forecast period, change this setting after setting the estimation sample.

6. Ex post forecasts and forecast errors are displayed in the Actual/Fitted and Residual plots. The main purpose of this option is to check model stability. Two test statistics are computed, appropriate to short and long forecast periods respectively. The chi-squared (short-period) test (Forecast Test 1) is the generalization of Chow's (1960) second test. and depends on the additional assumption of Gaussian disturbances under the null hypothesis.

7. The second test reported depends on the model. In single equation linear regression models, Chow's stability test statistic is reported (choose between F and Chi-squared forms by checking the box in Options / Tests and Diagnostics.) In other cases, where the need to re-estimating the model for sub-periods precludes generalizing the Chow procedure, a difference-of-means test applied to the squared residuals and forecast errors. This is asymptotically N(0,1) as both periods tend to infinity. This is called Forecast Test 2. If it is desired to compute this statistic for the linear regression case, simply open the Dynamic Equation dialog and select Actions / Evaluate at Current Values.

MULTI_STEP FORECAST METHOD

8. Two methods of computing forecasts and associated standard error bands are provided. The analytic method computes formulae for the mean and standard error of the forecast, and the plots show two-standard error bands corresponding to 95% confidence bands when the errors are Gaussian.

9. Lagged dependent variables entering through the AR or fractional model components in the Dynamic Equation dialog are replaced by forecast values to yield a true multi-step forecast. However, please note that lagged dependent variables included as Typed regressors (in the Linear Regression dialog for example) are *not* substituted in this way. True multi-step forecasts are not computed for this case.

10. The Monte Carlo method uses the fitted model to compute stochastic simulations of the process, and reports quantiles of the empirical distribution for each step. In this case all models, including those containing lagged

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dependent variables as regressors, are computed by dynamic simulation. Hence, true multi-step forecasts are reported in this case.

11. Two types of Monte Carlo plot are available. Time plots show the median and 2.5% and 97.5% percentiles, so that the plotted bands in this case show a true 95% confidence interval (neglecting estimation error) even when the disturbances are non-Gaussian. Alternatively, kernel densities can be displayed, for the complete empirical distribution of any forecast step.

12. Analytic standard error bands for regime switching models use a recursive algorithm, involving m^K function calls for M regimes and K steps ahead. In Hamilton's model, the number of effective regimes is M^(number of lags). Unless they converge rapidly, these calculations can become very time consuming. They are therefore terminated automatically after 100 seconds has elapsed. Unless the bands have converged sufficiently to be extrapolated thereafter, only the point forecasts are reported for the remaining steps. (NB: diminishing returns set in rapidly! Even raising this factor substantially could yield at most a couple of extra steps.)

13. The display mode for standard error/confidence bands, including omitting them, can be selected in Graphics Options.

14. In dated (daily/weekly) data, it is not possible to plot forecasts with date information beyond the end of the observed sample, since the information is missing. An error message is displayed. In this case, either change the date type to "No Dates", or extend the data set and supply the additional dates manually (This must be done outside TSM).

MONTE CARLO SETTINGS

15. The default number of replications is 1000.

16. Select either the mean or the median of the Monte Carlo distribution for reporting. In the former case, 2-standard error bands are also shown in the plots, and in the latter case, the 2.5% and 97.5% quantiles are shown.

17. To select the simulation mode and change the random number seed see Options / Simulation and Resampling.

18. The scroll bar allows selection of one of the forecast periods for a density plot. Note that the maximum selection varies with the setting for number of forecasts.

ACTUALS IN FORECAST PLOT

19. It is usually helpful in a post-sample plot to show some, but not always all, of the series for the estimation period. The default is to include the last 50 observations. This can be changed, and to include all available observations, simply enter any value large enough. Note that when the forecast period includes or overlaps the data period (as for ex-post forecasts) the actual values are always shown.

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CONFIDENCE BANDS

20. By default, confidence bands are enabled. It may be desirable to switch them off if, for example, a user-coded function contains lagged adjustment. These dynamics cannot be taken account of in the analytic formulae, which will therefore be incorrect.

PLOT DISPLAY

21. Ex ante forecasts can be viewed by listing values in the results window (see Options / Output and Retrieval) or graphically (Graphics / Ex Ante Forecasts). Check the "Display Forecasts Automatically" checkbox to have the main graphs displayed immediately a forecast is run. Use the Graphics menu to display plots individually, and additional items such as Monte Carlo distribution plots.

IMPULSE RESPONSES

22. The impulse responses (coefficients of the solved moving average process) for levels and also conditional (ARCH/GARCH) variances, will be plotted according to the radio button setting, in either impulse form, or step (cumulated) form, or with both plots on the same graph.

23. In a system of N equations, the responses shown are those on a dependent variable of an impulse to its own shock process only (N plots). If the "System" checkbox is checked, then the responses on each dependent variable of impulses to each shock process are calculated (N^2 plots). This checkbox has no effect in a single equation model.

24. There is no limit to the number of steps possible. To increase the maximum, select it and close-open the dialog.

25. Only the own-shock responses can be listed in the results window. For a listing of the full set, export the data to a listing file (see File / Listings / Save MA Coefficients).
    Note: Only the impulse responses are exported. Compute the step responses manually by cumulation, if required.

8.4 Options / Simulation and Resampling ...

SIMULATION OPTIONS

1. There are six ways to generate artificial shocks to drive the one-off simulations, Monte Carlo experiments and bootstrap tests. See the main documentation for details and formulae.

    * 'Model' uses the distribution specified by the likelihood function, if a maximum likelihood estimator is specified. If the estimator specified is not ML, then Gaussian shocks are used with variance equal to the residual variance from the last estimation.

    * 'Gaussian' uses normal random numbers with zero mean and the variance specified in the text field provided.

    * 'Bootstrap/Block Bootstrap' randomly resamples the actual residuals,

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with replacement. The resampled series is centred and multiplied by a bias correction factor of 'sample size/degrees of freedom' (i.e., n/n-k). The block bootstrap is implemented by choosing a block length > 1.

* 'Sieve-AR Bootstrap', an alternative to the block bootstrap for dependent data, whitens the residuals before resampling.

* 'Wild Bootstrap' preserves the heteroscedasticity of the original sample. Instead of randomly resampling, the data are randomly transformed by a drawing from a two-point discrete distribution.

* The wild bootstrap and sieve-AR methods can be combined, for dependent, heteroscedastic samples.

* The Fourier bootstrap resamples from the discrete Fourier transform of the residuals using the Rademacher wild bootstrap, and returns the inverse transform of the resampled series. An alternative to the sieve-AR, suitable for Gaussian homoscedastic residuals showing generalized autocorrelation.

2. Optionally (see the checkbox) the 'Model' method will always be used for one-off simulations and Monte Carlo experiments. This setting allows the specification of a Monte Carlo experiment where the bootstrap is used for tests, without the need to set up different for data generation and estimation.

3. The wild bootstrap variants are not available for Monte Carlo forecasts. If these options are selected, the regular bootstrap is substituted.

4. The random number seed is an arbitrary set of decimal digits. If set to 0 (default) the actual seed will be generated by the system clock, and every run will be different. Otherwise, the seed entered here will be used to initialize random number generation for each Monte Carlo forecast and stochastic simulation.

5. The setting 'Shock Variance' is available for Gaussian shocks only. If 0 is entered in the text field , then the sample variance from the most recent estimation is substituted. If this value is zero (as if no estimation has been run in the current session) then 1 is substituted.

6. The block bootstrap option is to allow valid bootstrap inference in mis-specified models with autocorrelated errors, provided the autocorrelation is not too persistent. The chosen block length value is shown as a power of the current sample size.

7. When 'ML Model' is selected, the parameters of the shock distribution are those shown in the Values / Condition Variance and Values / Distribution dialogs. In this case the setting of 'Shock Variance' is ignored.

8. By default the sieve-AR method used an increasing function of sample size as maximum lag order. For this case, enter "-1" in the Max Sieve-AR Lags text

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field. Setting a zero or positive value over-rides the default. Setting "0" is equivalent to the regular bootstrap method.

9. If 'bootstrap' is selected and the random number seed is set to -1, the shock-generation procedure returns the actual model residuals, in original order. The generated series should then be identical to the original data series, apart from possible rounding error. This feature provides a check that the simulation module is inverting the fitted model correctly. (Note that to generate Markov-switching models also requires a latent switching process, so this check will be valid only if the Markov transition matrix is fixed at the identity matrix.)

10. The option "wild bootstrap skewness" sets the parameter 'a' such that the t-th drawing is e.u_t where u_t is the sample value (fixed), and e = a and -1/a with probabilities 1/(1+a^2) and a^2/(1+a^2) respectively. Note that this setup preserves the first two marginal moments of the distribution. The default is a = 1, which always yields a symmetric distribution, but preserves kurtosis. Setting a = 1.618 preserves the original skewness (if any) but doubles the kurtosis. The value of the Kolmogorov-Smirnov statistic, comparing the fit of the original data points to the bootstrap distribution, is reported to aid the best choice of this value.

SIMULATION PRESAMPLE MODE

11. If a dynamic simulation run starts at observation 2 or later, the initial observations can be generated in two ways, either fixed or random. If fixed, the actual values of the selected dependent variable are used. If random, the sequence is randomly set in each replication, using generated or resampled shocks and the specified model. In other words, the simulation actually initializes at date 1, whatever the nominal start date.

    * If a partial sum process (unit root) is specified, the cumulation begins at the start date, not at date 0.

    * The random presample option can be selected for Monte Carlo experiments. Fixed (actual) values are always used for bootstrap tests and Monte Carlo forecasts.

    * The setting makes no difference if the simulation start date is 1.

TYPE I FRACTIONAL PROCESSES

12. A fractional (ARFIMA) model has long memory, and can depend significantly on remote pre-sample influences. If these processes are simulated by setting presample shocks to zero (the 'type II' model), this changes the distribution of estimators and test statistics even in large samples. The 'type I' model can in principle be simulated by selecting the random presample option and setting a long presample period. However, the number of lags required for a good approximation may be excessive. The option 'Generate Fractional Series as Type I' (set by default) simulates the effect of presample lags by adding a single vector (or matrix) of Gaussian random variables with the correct covariance

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structure. Selecting this option ensures that (e.g.) bootstrap distributions match the type I case.

Notes:

1) With this option the fractional process must be stationary, i.e., d < 0.5. To simulate a nonstationary process, replace d by d - 1, and check the option "Impose Unit Root" in Model / Dynamic Equation.

2) The option is not available in conjunction with regime switching. A type I process is always generated in this case.

3) If the Presample data are held fixed in the simulations (required in bootstrap and Monte Carlo forecasting) estimates or imposed values of the presample shock components must be available. The number of these to be included is set in the "type I Fractional" text box in Options / General; if the setting is zero, the type II process is generated.

INFERENCE BY RESAMPLING

13. Two methods are implemented for generating confidence intervals and p-values by resampling the data, rather than by asymptotic criteria.

    * The bootstrap simulates the specified model using the TSM simulation engine with randomly drawn artificial disturbances. These can be either drawn from a known distribution, such as the normal or Student's t, or resampled from the empirical distribution of the estimated residuals. Monte Carlo simulation of the estimation procedure yields the bootstrap distribution.

    * Subsampling is the method of fitting the model to successive contiguous subsamples of the data set, and constructing the empirical distribution of the subsamples. It does not involve drawing random numbers.

14. The output is available in the form of confidence intervals, p-values and plots of the empirical distributions generated.

15. By default, resampling is deselected automatically after a single run ("Once"). There is an option to select it permanently as the inference method ("Always"). Selection is indicated by a flag on the status line, '(B)' for bootstrap and '(S)' for subsampling.

16. The number of replications determines the accuracy with which the p-value is measured. However, because of the small-sample error in the p-value (due to replacing actual with estimated parameters) the accuracy attained from a large number of replications is typically spurious. The default of 99 (implying accuracy is bounded by 1%) is probably adequate in many cases. 399 would be sufficient in nearly every case.

17. The bias correction option subtracts an estimate of the bias from each

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parameter point estimate. This is computed as the difference between the mean of the bootstrap distribution and the point estimate (estimating, respectively, the mean of the estimator distribution and the true value).

18. The fast double bootstrap is a device aimed at reducing the error in rejection probability of bootstrap tests. It is not guaranteed to improve performance in all cases, but showing that test outcomes are invariant to this selection offers additional robustness.

RESAMPLING CONFIDENCE INTERVALS

19. Resampling allows true confidence intervals for parameters to be estimated. Three schemes for 95% confidence intervals are implemented.

Equal tails:	2.5% of probability mass in each tail, but if the distribution is skewed, the point estimate is not the mid-point of the interval.
Equal tails percentile t:	intervals based on quantiles of the distribution of t statistics, weighted by standard errors from the resampling distribution.
Symmetric percentile t:	intervals based on 95% quantile of the absolute t statistics, centred on the point estimates, but tail probabilities are unequal if the distribution is skewed.

NEWTON-RAPHSON ALGORITHM

20. The model is re-estimated with simulated data in each replication. For models estimated through the Dynamic Equation dialog, this means numerical optimization. Since the "true" values (defining the artificial DGP) are available for starting values, the Newton-Raphson algorithm is used for these steps. The (numerical) Hessian of the criterion is evaluated at the true point.

21. Numerically precise convergence is not required to reproduce the distribution adequately. The time taken in the replications can be controlled by both limiting the maximum number of NR iterations, or raising the convergence criterion, or both.

22. NR is always used for bootstrap iterations. The algorithm can optionally be used for Monte Carlo experiments (instead of BFGS) by checking the checkbox.

8.5 Options / Graphics ...

GRAPHICS FILE FORMATS

1. The graphics output formats available depends on the platform and the program configuration.

   * PNG is a standard bitmap format, providing an exact image of the

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displayed window in the dimensions specified (see below). IrfanView is an excellent free graphics program for Windows that will display PNGs, and also convert them to JPG, EMF, GIF and other popular bitmap formats.

* EPS and EPC are vector graphics formats. They can be viewed with the free package GhostView, which will also convert them to PDF. They can be loaded directly into Word and TeX documents, and can also be edited in various drawing packages.

* The GIF option works in UNIX/LINUX, but does not work currently on the Windows platform.

2. If the checkbox "Save Automatically" is checked, every graph is saved to disk in the chosen format, at the same time it is displayed. Otherwise, the menu item File / Graphics / Save Last Graphic saves the one most recently displayed.

3. .GWG (GiveWin format) files are created if the compiler directive #DEFINE OXDRAW appears in the run file. This option loads the OxDraw graphics package, and disables GnuPlot, so display within the program is not available. The format settings in this dialog are ignored. See the main documentation for more details.

4. Checking the option "Monochrome Plots" yields graphics suitable for reproduction in black and white. Coloured lines are replaced with patterns (solid, broken, dotted etc.) In Windows, these patterns can be edited by clicking the top left corner of the Gnuplot display window and choosing Options / Line Styles... .

5. Files with extension .PLT are created by GnuDraw for processing by GnuPlot. These are text files that can be edited for further processing if you know the GnuPlot command language. If the box "Keep PLT Files" is checked, these files are retained in the results folder after creating a graphics file. Otherwise they are deleted automatically.

DATES IN PLOTS

6. By default, when observation dates are specified they are displayed on the time axes of plots in the format YYYY (the year). Other options are to show month and year, in the formats MM/YY or MM/YYYY, and to display observation numbers ("No Dates").
   NOTE: With daily/weekday data, the date indication is generally approximate, since there is no allowance for missing days such as holidays. However, in most daily data sets with large numbers of observations, the axis labels will be an adequate approximation.

7. If individually dated weekly/daily observations are plotted, the dates can be shown in the additional formats DD/MM/YY or YY-MM-DD, as well as the styles listed under 7.

8. The default date display mode is selected automatically when a new data set

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is loaded. Alternative settings must then be re-selected in the dialog.
The defaults are:

* YYYY for annual or quarterly data.
* MM/YYYY for monthly and higher frequencies.
* DD/MM/YY for dated (daily or weekly) data.
* 'No Dates' for undated data.

BITMAP DIMENSIONS

9. The dimensions of PNG bitmaps are selected by entering the numbers of column and row pixels desired. The default is 640x480. If 0 is entered in the column (row) field, the setting is automatically calculated as 3/4 times the row value (4/3 times the column value).
NOTE: These settings do not affect the screen display.

'ACTUAL-FITTED-RESIDUAL' PLOTS

10. The "Double-Chart" button on the toolbar displays, by default, time plots of the actual and fitted values and the residuals. The button is disabled until an estimation has been performed. If the option "Extended Actual-Fitted-Residual Plots" is checked, two additional plots are shown; the actual-fitted scatter plot, and the histogram and kernel density of the residuals, together with the normal density curve with matching mean and variance, for comparison.

CONFIDENCE BANDS

11. By default, multi-step forecast plots show 2-standard error confidence bands, or 95% estimated confidence bands in the case of Monte Carlo forecasts.
The following options available for confidence band plotting.
None: also effected by turning off calculations in Options / Forecasts.
Bands: additional lines are plotted to show 95% region.
Bars: the default - 95% confidence region marked by vertical bars.
Fan: coloured bands mark six different confidence regions around the point forecast. The confidence levels are 40% (yellow), 60% (ochre), 80% (brown), 90% (mauve) 95% (light purple), 99% (dark purple).
Notes on fan plots:
    1: Reversing the colour bands is a setup option, see Appendix B.
    2. Fan plots cannot be combined with other plots, or other graphs in the same frame. (This is a Gnuplot limitation). The pre-forecast 'actuals' series is plotted as a 'zero-width band', coloured dark purple (no symbols).
    3.: Fans are not available for monochrome plots, or recursive forecasts. The default option (bands) is used in these cases.

MULTIPLE SERIES DISPLAY

12. There are three ways to plot several series at once:
    * Individual: each plot in its own frame.
    * Separate plots in the same frame (default).
    * All series in the same plot.

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The last option can also be selected in the Graphics / Show Data Graphic dialog, in which case the style of each line is selectable. Note the option to plot the last selected series against the right-hand axis in this case.

13. If a system is estimated, the above three options are available for plotting the series associated with each equation: actuals, fitteds, residuals etc. If the "Individual" option is selected, only the series for the equation selected in the "Equation" choice widget on the tool bar is plotted.

LINES AND SYMBOLS

14. Series can be plotted by lines connecting the data points (default), by symbols at the points, or by both. This is a general setting. The choice of colours and styles for each line can be selected in the "Line Styles" area. Note that the selection of symbols can be overridden for individual lines by choosing "None" in the symbol choice widget.

LEGENDS

15. Legends are used to label series when two or more appear in the same frame; otherwise, the series name appears as the plot title. There are five options for placing the legend in the frame:
    X: No legend.
    TL: Top left corner (default)
    TR: Top right corner
    BL: Bottom left corner
    BR: Bottom right corner
    Note that these are general settings. It is not possible to place the legend differently in different plots in the same frame.

16. Check the "Box" checkbox to enclose the legend in a box. By default, no box is shown.

CRITERION PLOTS

17. There are three options for the plot created by Actions / Plot Criterion Grid. If "both" is selected, the resulting plot is the same as the surface plot with contours drawn on the 'floor' (p_1, p_2 plane) of the three-dimensional graph.

DENSITY PLOTS

18. These plots are available under Resampling Distributions to display bootstrap and subsampling distributions, Monte Carlo Distributions to show the empirical densities of the replicates, and also under Ex Ante Forecasts to show Monte Carlo forecasts. The basic plots show the kernel density estimate. Optionally, the plots can also show the histogram (selected by default) and the normal curve with matching mean and variance. A further option is to plot the cumulative distribution function (CDF) in a companion frame.

LINE STYLES

19. Eight line styles for series plotting can be set by the user.
    The selectable option are line colour (or pattern, for monochrome plots),

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line width, symbol type, and symbol size. First select the line to be styled with the radio buttons. Then select options with the line and symbol choice widgets, and line width and symbol size fields.

* Available line widths are 1 (thinnest, default) to 6 (thickest).
* Symbol size can have any positive value, 1 is default.
* Monochrome lines can take any width, if solid.
* Patterned lines (dots, dashes, etc.) are always of thickness 1.

Press the 'Restore Defaults' button to set all line settings to defaults.

20. The Colour/Pattern widget shows different options, depending on whether the Monochrome Plots option is selected. Note that both settings (colour and pattern) are remembered. Switching between colour and monochrome plots does not delete the options.

21. The eight line styles are can be selected for data series plotting in the Multi-Series plot option in Graphics / Show Data Graphic.

22. If a multi-series graph is plotted by selecting 'One Graph' under Multiple Series Display in this dialog, the line styles are used in order, starting with 1.

23. Equation graphics are drawn using line styles 1-4.
    * Style 1 is used for the main series in each plot, including the 'Actual' series in Actual/Fitted plots.
    * Style 2 is used for 'Fitted' series.
    * Style 3 is used for forecasts
    * Style 4 is used for confidence bands.

24. If multiple equation series are plotted in a single graph, the line styles are incremented by two, or three, so as to cycle through the available styles.

25. The symbol option 'Fill' does not draw a symbol, but shades the region between the line and the zero axis using either light gray in colour plots, or a hatching pattern in monochrome plots.
    This option is used by default in the display of probability and conditional variance series. Uncheck the checkbox to use the Line Style 1 for these series.

26. The "Band Fill" line style is a special option to indicate regimes or time periods, depending on the value of the selected variable. It displays light gray bands in those periods when the variable is positive.
    NOTE: Band Fill can only be selected for Line 8. Attempting to select it for Lines 1-7 produces a warning message.

27. The option "Plot Zero Axis" is selected by default. The zero axis in a plot is drawn as a light grey broken line. When the option "Scale on Right Axis" is selected in Graphics / Show Data Graphic there may be two zero axes marked, for the left- and right-hand scales respectively.

SCATTER_PLOT OPTIONS

28. Scatter plots styles allow the form, colour and size of symbols to be chosen. Scatter 1 is used for all data plots, and for actual-fitted plots.

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Scatter 2 is used only for the post-sample actual-forecast scatter when the one-step forecasting option is selected.

29. By default, scatter plots of data include the two regression lines (X on Y and Y on X). In the case of the actual-fitted scatter, the single line with slope 1 is drawn (a 45 degree line when the axes match). These lines can optionally be suppressed.

30. The RGB Scatter option colour-codes the plotted points according to their position in the sample. The initial points are coloured red, those in the middle green, and the end of the sample blue, with a smooth interpolation from one colour to the next. Try plotting the scatter of a variable against the trend dummy to see the effect. Select a 'filled' symbol (square, circle or triangle) for best results. If monochrome plots are selected, the coding is a greyscale, running from black to white. This option is not available for actual-fitted plots which include post-sample actual-forecast points.

8.6 Options / ML and Dynamics ...

ML PARAMETERIZATION

1. The residual variance and GARCH intercept are scale-dependent parameters, bounded below by zero. In some models, such as highly persistent FIGARCH models, the GARCH intercept can be very small and estimation close to the parameter boundary poses numerical problems. These are eased by making the square root (or other fractional power) the parameter to be estimated. The default value, which works well in most cases, is 2. Try raising this to 4 if there is evidence of a problem. Set to 1 to estimate the variance/intercept directly. Be careful to set the starting value and interpret the estimate appropriately.

2. The Student's t degrees of freedom (d.f.) parameter is bounded below by 2, and is infinite in the Gaussian case. A square root transformation (the default) better numerical performance in the vicinity of these can yield extreme values. Setting the order of root to a negative value allows the estimation of the inverse d.f., which takes the value zero in the Gaussian case.

3. Note: the variance/GARCH intercept and Student t d.f. parameters are constrained to be nonnegative during optimization by taking the absolute value of the parameter element to evaluate the likelihood function.

4. By default, the Student skewness parameter is non-negative and equal to1 in the symmetric case. Estimating the logarithm makes 0 the symmetry value, and may yield better numerical properties. (In the default case, nonnegativity is enforced as in 3.)

DYNAMIC MODEL SETTINGS

5. By default, up to 10 lags can be set in the ARMA and GARCH models. This maximum can be reset to any desired value in the text box.

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6. There is no accepted convention regarding the signs of the coefficients of a moving average lag polynomial. The program default is to report the MA coefficients theta_j in

theta(L) = 1 - theta_1 L - ... - theta_q L^q,

and GARCH coefficients as beta_j in

beta(L) = 1 - beta_1 L - ... - beta_r L^r .

This is consistent with the convention in equation (4) of the main document, and also more natural. For example, in the ARMA(1,1) model equal roots cancel each other out, and in this case the estimates will be equal. Similarly, in the ARMA-in-squares representation of the GARCH(1,1) model, beta_1 = delta_1 corresponds to alpha_1 = 0, and the estimates are again equal in this case. However, the MA coefficients can be optionally reported as theta_j in

theta(L) = 1 + theta_1 L + ... + theta_q L^q,

and GARCH coefficients as beta_j in

beta(L) = 1 + beta_1 L + ... + beta_r L^r.

7. If the first observation for estimation is greater than 1, lag distributions will normally be computed using all available pre-sample lags. Checking 'Restrict Pre-Sample Lags' allows the number of presample lags to be set in the textbox provided. Thus, setting 'Lag Truncation' to 0 means that all pre-sample values are replaced by 0. This provides comparability with the situation when the first observation used for estimation is 1.

8. For details of the option "Type I Fractional" see 4.2 Model / Dynamic Equation, and Davidson and Hashimzade (2006). Note that this feature is experimental!

GARCH PARAMETERIZATION

9. As the default, GARCH coefficients are reported in 'ARMA-in-squares' form, in which delta(L) and beta(L) in equations (2) and (3) are the AR and MA components. In this case the coefficients are named "GARCH AR1", "GARCH MA1" etc., etc. Optionally they can be reported in 'standard' form, corresponding to the representation of Bollerslev (1986). In this case, the coefficients named "GARCH Alpha1" etc. are the coefficients of beta(L) - delta(L), and "GARCH Beta1" etc. denote the coefficients of beta(L).

Note:

* Roots of the GARCH AR polynomial are not reported when this option is checked.
* The EGARCH model does not strictly have an “ARMA-in-squares” representation. The default corresponds the stated form of equation (3). The 'Bollerslev' form is the one more commonly reported.
* It is the user's responsibility to match starting values to the convention selected.

10. The GARCH intercept can also be computed in two different ways. By default, it is 'omega' in equations (2) and (3). By unchecking the box "Specify 'Type 1' GARCH Intercept", kappa = omega*beta(1) will be

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computed instead, see equation (44)ff of main document.

OPTIMIZATION SETTINGS

The following options should not normally need changing, but the defaults may not suit all cases. Experimentation is recommended if in doubt.

11. The GARCH-M likelihood is computed by Gauss-Seidel iteration of equations (1) and (41), (or (1) and (42) for EGARCH). A fixed number of iterations is used, the default is 5. Increasing the number will increase computation time, but may not improve the estimates significantly.

12. To stabilize the GARCH-M calculations, h_t (or h_t^{1/2}) is trimmed before inclusion in equation (1). The upper bound is set to a multiple of the sample variance (or standard deviation) of the data, called the trimming factor. Try reducing this setting in case of failure of the algorithm.

13. The EGARCH likelihood can be computed in one of two ways; direct nonlinear recursion of equation (42) (default) and Gauss-Seidel iteration; i.e., repeatedly solving the linear difference equation obtained by conditioning on h_t^{1/2} in equation (42). There may be small differences between the two estimates due to treatment of initial conditions. The main consideration in this choice is one of speed. The nonlinear equation cannot be solved using Ox's vector manipulation capability, and has to be programmed as a loop. This could result in long solution times in large samples, and the iterative method will often be quicker. A convergence criterion is used to control the G-S iterations. The default maximum number (50) should not need changing.

8.7 Options / Optimization and Run ...

OPTIMAND CONVENTION

1 Two of the estimators available (least squares and GMM) are conventionally regarded as minimizing a criterion, while the ML options are maximands. This can lead to confusion, especially when interpreting the model selection criteria. The "optimand" for least squares and LGV is reported for comparability as the Gaussian log-likelihood (a monotone-decreasing transformation of the sum of squares) but the GMM optimand has no such counterpart. By default, all the estimation criteria are treated as maximands, (so, -GMM criterion). The 'Report Minimand' option reverses the signs (so, -Log Likelihood). The important issue is that the selection criteria are always signed in the same way as the estimation criterion, and so are to be minimized (maximized) if this option is checked (unchecked).

NUMBER OF GRID POINTS

2. Enter an integer value here to choose the density of points computed in a grid plot. If N is set, then N+1 points are evaluated in a 1-dimensional grid, or (N+1)^2. points in a 2-dimensional grid. Note that grid plotting must be enabled in Values / Equation, and the run launched with Actions / Plot Criterion Grid. Set the grid bounds(s) in the relevant Values dialog(s).

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BOUND ON DYNAMIC PARAMETERS

3. The absolute bound on dynamic parameters controls a penalty applied to the criterion function, to prevent extreme values. The penalty is applied only to dynamic parameters (ARMA and GARCH coefficients, and ARFIMA/FIGARCH d). This is mainly to prevent (e.g.) inverted moving average roots diverging to infinity. It will not normally need to be changed. To remove, set it to a large value.

OPTIMIZATION SETTINGS: BFGS ALGORITHM

4. The options Maximum Number of Iterations, Iterations Print Frequency, Strong Convergence Criterion and Weak Convergence Criterion are set to their Ox defaults with the value -1. They will not normally need to be changed.

5. Printing of the current position and gradient is performed every N iterations, where N is the print frequency. This output is under the control of the Ox routine, and will not appear in the TSM results window. It goes only to 'standard output', meaning either the console window or OxEdit/GiveWin output, depending on operating mode. Set frequency to 0 for no printing.

6. Due to rounding error, the efficiency of the search algorithm can be sensitive to large differences in scale between parameters. This can be due to inappropriate units of measurement, for example. Setting the Parameter Rescaling Factor to 1 adjusts parameters to have a similar order of magnitude, based on the starting values - hence this setting alone will not have any effect with default starting values. However, setting to a value greater than 1 scales all parameters up, to limit rounding error. The value of 10 appears to improve the performance of the algorithm in at least some cases. However, no verified guidelines can be offered. Experiment! (and report your findings, please.) To disable rescaling (the default) set the factor to 0.

SIMULATED ANNEALING

7. Optionally, a simulated annealing algorithm can be run for a fixed number of iterations to provide starting values for BFGS. This option is selected by default. By choosing a large number of iterations, SA can be effectively made to act as the search algorithm proper. However, given good starting values BFGS should be much faster, so a compromise is probably best.

8. The other three settable SA parameters are the initial temperature, the temperature reduction factor, and the number of iterations before temperature reduction. None of the defaults are necessarily best. If the number of iterations before temperature reduction is set <= 1 it is replaced by the default of max(100, 5*(#parameters)). This setting appears as .NaN in the text field.

NON-CONVERGENCE

9. If the BFGS search algorithm reports convergence failure, then by default the parameters are set to default values and no output is returned. Optionally, however, the output can be printed as usual using the current

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point attained by BFGS. Be cautious in interpreting these values, and especially standard errors. A possible cause of failure is a non-unique likelihood optimum. In that case the reported values should represent an optimum point, but the standard errors and covariance matrix are typically not meaningful.

RUNNING AN EXTERNAL PROCESS

10. If the option "Run Next Estimation as External Process" is checked before launching an estimation run, the calculations are run in a new instance of Ox, running in a console window. A temporary executable Ox file is created to be run in batch mode.

11. This option allows the TSM GUI to remain under the user's control for other tasks while a long numerical optimization is performed. It also allows two or more jobs to run be concurrently. Since Ox is not multi-threaded, this is the best way to make full use of a multi-core processor.

12. This option is always cancelled once the run is executed. Reset it in this dialog as required

13. The usual estimation results are written to a text file identified by the run number. Import this text to the results window using the command File / Load Text File.

14. If the specifications are stored as a named model in Model Manager before running the new process, the associated values and listings can also be imported. A ".tsd" data file is created with the usual outputs. Import the data by RE-loading the model in Model Manager. Also, the estimates can be loaded for further processing by the command Restart / Load Text Input. The name and path of the file to load is given in the results window.

15. If the option "Delete Temporary Files on Exit" is checked, the temporary code and listing files created by this option are deleted at closedown. Results files are not removed, and must be deleted by hand, as required.

8.8 Options / General Options ...

OPERATIONAL SETTINGS

1. Dialogs are closed when an estimation run is started. Checking the option "Restore Dialogs Automatically" causes them to re-open in the same positions at the end of the run. Dialog positions are stored in “settings .tsm”, so the last configuration in the previous session will also be restored at start-up. If this option is not selected, dialogs can be restored manually using the Actions / Restore Dialogs command.

2. The positions of dialogs on the screen are remembered during a session, but by default are lost when the program is closed. They are positioned centrally when first opened. Optionally, the program will remember the positions

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between sessions. This allows the user to maintain a preferred screen layout, but note that if the monitor resolution is changed, they could become invisible. In this event, use the command Actions / Reset Dialog Positions to re-centre them.

3. By default, the user is prompted to save data/results before over-writing them or closing the program. Deselecting "Enable Saving Prompts" suppresses these reminders.

4. Saving program settings in a file allows the exact state of the program to be restored, by reloading the settings. These include the data file, sample, model specifications and current estimates. This can always be done manually, but the option "Save Settings After a Run" saves the settings automatically in a file "run*.tsm" where * denotes the ID number of the last run. Enabling this option allows an earlier estimation run to be re-created instantly, by loading the requisite file (see 2.1 File / Settings / Open...).

5. The currently stored results (estimation output, graphs, series, Monte Carlo results etc.) can be saved in the settings file at closedown, along with the settings and model specifications. This means that the last estimation results can be redisplayed without having to be recomputed. (Click the "Evaluation" button, then "Yes"). The program is in almost exactly the same state as at the last closedown, but the complete contents of the results window are not stored. Save these in the usual manner.

6. Enabling the option "Delete Temporary Files on Exit" will cause .TSD (model results and data) files to be deleted automatically at the end of a session. Uncheck this if you wish to keep your model results, or check it to avoid excessive clutter in your working directory.

7. Data descriptions are saved as series name extensions, that may not be compatible with other programs. Set the option "Omit Data Descriptions" when exporting data for use in other packages.

8. "Automatically Close Options Dialogs" is selected by default, and has the effect of closing any options dialog currently open when another is opened. This saves a proliferation of open dialogs on the screen, but can be disabled if it is desired to work on two or more options dialogs at once.

DISPLAY SETTINGS

9. The default font size of 12 points should suit most monitors, but can be changed. This setting also effects the help pages, whose widths are increased to accommodate the larger text. The results window is resizable by dragging the corner with the mouse.

10. TSM output can be echoed to the console as well as appearing in the results window. To enable this behaviour check the "Echo Results to Console" box. Output from Ox not under the control of TSM, such as error messages, will also to appear in the console window.

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11. Tool tips appear by default when the mouse pointer is passed over the tool buttons. These can be optionally switched off.

12. If the Enable Error Recovery option is checked (the default) the program restarts automatically in the event of a crash (Ox error). Note that the Ox error message appears in the DOS console.

13. Drag selection allows the quick highlighting of a block of adjacent variables in any list allowing multiple selection. Select a variable as usual, then put the mouse pointer on another variable, and "drag" briefly (hold down the mouse button while moving the mouse). These actions select all the names in between. Deselection works the same way. The option can be switched off in case it fails to operate smoothly on particular systems.

LINEAR REGRESSION MODE

14. To simplify the user interface for teaching purposes, the options for nonlinear estimation by numerical methods can be disabled, and the toolbar buttons hidden. For this option, uncheck "Enable Optimization Estimators". A restart is required to implement this selection.

DEFER EXTERNAL JOBS

15. Check this option to create batch jobs (estimations or Monte Carlo jobs) as executable Ox files, for starting manually. Use this option to run the job on a different Ox installation, or to defer running it until a convenient time. When this option is unchecked (the default) the job is started immediately the Run command is given.

ASSIGNABLE TOOLBAR BUTTONS

16. The two toolbar buttons with the "Dialog" icon and a number can be assigned to open any dialog that does not have a dedicated button. Simply open the dialog you wish to assign, then click one of the two assignment buttons. This also works for the Grid Plot and Simulate commands on the Actions menu. Note:
    - Unassigned buttons simply re-open the last dialog opened.
    - To remove the current assignment, "assign" a dialog which has its own toolbar button.
    - To assign an Options dialog to a button, first uncheck the "Automatically Close Options Dialogs" checkbox. This allows you to open another Options dialog without closing this one.
    - To assign Options / General itself to a button, press an assignment button before opening any other dialog.

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9. Help

* "User's Manual" gives access to these pages.

* "View Text Files" opens additional documentation in ASCII files, for reading only.

* "Data Descriptions" opens a list of names of the currently loaded variables, followed by any description that has been created for the variable. The description is preceded by the symbol @.

* "Register this Copy..." opens a dialog to enter the user's name and the unlocking key provided to registered users of the software.

* "About" opens a box showing copyright information and the registered username.

USER'S MANUAL

1. Navigate the User's Manual by the menu (sections) and sub-menus (subsections), and also by clicking the "Previous" and "Next buttons to move backwards and forwards through the pages. These pages duplicate the contents of the PDF file "tsmod4ghp.pdf", which is accessible through the Start Menu (Windows).

VIEW TEXT FILES

2. "File Dialog" opens the file dialog, to select any ASCII file for reading.

3. "Most Recently Opened" repeats the last selection. By default (if no file has yet been opened) it opens "notes.txt" if this file exists.

4. 'Imported Ox Code' refers to a source code file, with .ox extension, which has been loaded from a distributed settings (.tsm) file. A distributor of coded functions has this opportunity to document their code, by including text comments in the file before the code statements. The code itself can also be inspected.

DESCRIPTIONS

5. Data descriptions can be created in two ways. In Setup / Data Editing and Transformations, the choice widget item "Description" opens a text field where the description of the selected variable(s) can be entered. Alternatively, when the data are prepared for loading in a spreadsheet or text editor, add the description text to the variable name, normally preceded by a @ symbol. The delimiter symbol can be changed by editing the tsmgui4.h file.

6. Some entry formats, such as .DAT, limit the length of a variable name. Overflowing text will be lost if the data are saved in this format.

REGISTRATION

7. The username must be entered in exactly the format as given with the

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unlocking key. Changes in (e.g.) spelling, capitalization, embedded spaces, etc., will cause the registration to fail.

8. The program saves the licence file "registration.txt" in one of the two valid locations for this file. It first tries the TSM Home directory, i.e., [ox home] /packages/tsmod4/. If either the user does not have permission to write in this folder, or if a licence file already exists there, it writes to the current Results folder. This allows several different licences to coexist on the same workstation, if each user maintains a different Results folder.

9. By default, the Results folder is the "start-in" folder specified in the short-cut used to start the program. However this location can be changed (e.g. by the command "File / Results / Locate Results Folder"), and new location is saved in "settings.tsm". If the settings file is subsequently deleted, it will be necessary to either restore the Results location, or move the licence file manually to the new one

10. TSM reads the licence file at start-up, and looks for it in the current Results folder first. If it is not found there, the program looks in the TSM Home directory. If a licence file exists in the current Results folder it will 'take precedence', and any licence file stored in the TSM Home directory will be ignored. To "see" the latter registration, change the Results folder.

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10. Interpreting the Output

PARAMETER LABELLING

1. The symbols AR1, AR2, ..., MA1, MA2,... are used to label the ARMA coefficients in the output. The prefixes 'GARCH', 'EGARCH' or 'APARCH', as appropriate, are appended for the conditional variance coefficients in the default case of the 'ARMA-in squares' parameterization. For the standard (Bollerslev) parameterization, 'AR' and 'MA' are replaced by 'Alpha' and 'Beta', respectively. These notations are also used for the BEKK multivariate GARCH model. Be careful to interpret the latter parameters correctly!

2. For models specified in the Model / Dynamic Equation dialog, the 'Type' of a regressor appears as a prefix in square brackets, for example, "[1]Var1" denotes that Var1 is a regressor of Type 1. This prefix is omitted if only Type 1 regressors are specified, and also in equations specified in the Model / Linear Regression dialog.
Note: in the latter case the Type only controls the number of lags generated, not the interpretation of the coefficients.

3. A GARCH regressor is indicated similarly, with an additional "G" prefix. For example, "[G1]Var1" denotes that Var1 is a GARCH regressor of Type 1. The GARCH (or EGARCH or APARCH) intercept of Type 2 ('kappa') is indicated with the prefix '[2]'. However, no indicator is used for the GARCH (EGARCH, APARCH) intercept of Type 1 ('omega').

4. To indicate the regime in an explained regime-switching model, the regressor has an additional "Rg" prefix. For example, "[Rg1]Var1" denotes that Var1 is a regressor explaining the probability of switching to Regime 1.

5. In smooth transition models, the parameters of the single and double transition factors are indicated with the prefix "Sm". For example, "[Sm1]Intercept" denotes the location parameter of the first transition factor.

6. The bilinear model is described in the output as 'Bilinear-AR(F)IMA(p,r,d,q) where r refers to the selected bilinear order, and p, d and q are as for the standard AR(F)IMA model.

PARAMETER ROOT TRANSFORMATIONS

7. By default, the GARCH intercept term is estimated in square root form. Correspondingly, in ML estimation of models without a conditional variance component, the error standard deviation is estimated by default. This is for reasons of numerical stability. Particularly in IGARCH models where the parameter can be close to zero, numerical derivatives can be highly inaccurate without a rescaling transformation. The transformation can be selected by the user in the Options / ML and Dynamics dialog. In certain cases, raising the order of root from 2 to 4 may be found to aid

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convergence, while in others 1 will work satisfactorily

8. Similarly, the parameter of the Student t distribution can optionally be estimated as a root of the degrees of freedom. The square root is the default. See the Options / ML and Dynamics dialog to set alternative values. This is again for reasons of numerical stability. The parameter is both bounded below, and infinite in the Gaussian case, and extreme values are potentially difficult for numerical differentiation. By setting the root to a negative value, the inverse transformation can be applied, such that the parameter is zero in the Gaussian case.

STANDARD ERRORS, TEST STATISTICS AND P-VALUES

9. Every estimated parameter is shown in the output with either its estimated standard error , or the words "Fixed" or "Solved" when the parameters have been so designated in the Values dialogs. Following the standard error, most parameters show the t ratio and nominal p-value of the significance test. The degrees of freedom are calculated as "sample size - (total model parameters)/(number of equations)".

10. Parameters for which there is no natural "zero hypothesis" to be tested, such as the variance, GARCH intercept, Student's t degrees of freedom, etc., are shown with standard error in parentheses but no p-value.

11. Nominal p-values are also given for quoted test statistics, in many cases asymptotic chi-squared statistics. For tests with non-standard distributions (Dickey-Fuller, KPSS, R/S) these are computed from the available tables. Since the coverage is incomplete, these results are shown as inequalities. Thus, {<0.05} would denote that the p-value is less than 0.05 (leading to rejection at the 5% level) according to the table. The result {<1} simply indicates that the statistic falls within the bounds of all the tabulated points. The tables themselves are given as an appendix to the main document.

12. If standard errors and/or test statistics print as NaN, (stands for "not a number") this means the Hessian matrix of the optimization criterion could not be inverted at the current point. Typically, this means the local optimum is not unique, which will also cause convergence failure. Lack of identification is a leading cause; for example, a Markov switching model with a zero-probability regime. When Print Covariance Matrix is selected in Options / Output and Retrieval Options, the Hessian matrix itself is printed in this case, as a diagnostic aid. Checking for zero rows and columns could indicate the source of the problem.

SELECTION CRITERIA AND SUMMARY STATISTICS

13. By default the model selection criteria (Schwarz, Hannan-Quinn and Akaike) are defined as "maximand - penalty". Therefore, larger values are preferred. This convention can be optionally reversed, see "Report Minimand" in Options / Optimization and Run.

14. "R-Squared" is the squared correlation coefficient between the dependent variable Y, and the model predictions (= actual Y - residuals). Therefore,

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it is well-defined for any model, and must lie in [0,1]. However, whether it is a useful measure of model performance depends on the model - it is of no use in assessing GARCH models, for example.

15. "R-Bar-Squared" is calculated as 1 - (1 - R-squared)*(T-1)/(T-p) where p is the number of parameters fitted in the model.

16. When models are estimated by Instrumental Variables from the Linear Regression menu, the Sargan and DWH (Durbin-Wu-Hausman) statistics are given. These are asymptotic chi-squared statistics under H0, with degrees of freedom indicated, and nominal p-values shown in braces. The Sargan statistic is N times the ratio of the GMM minimand to the residual sum of squares, where N is sample size. This tests validity of over-identifying restrictions. The DWH statistic tests for valid exogeneity assumptions on the instruments, and is N*(RSS0 - RSS1)/RSS1 where RSS0 is the sum of squares from the OLS regression, and RSS1 the sum of squares from the regression including the reduced form residuals for the included endogenous variables.

CONVERGENCE ISSUES

17. All estimations specified in the Model / Dynamic Equation dialog are done numerically. The optimization routine is the Ox implementation of the Broyden-Fletcher-Goldfarb-Shanno (BFGS) quasi-Newton procedure, with numerical derivatives. This method reports strong convergence in a high proportion of cases. However, don't assume that the message "Strong convergence" means that the estimation criterion has been globally optimized. It simply means that a local optimum has been found. Restarting the search algorithm from different points is the only way to confirm a global optimum.

18. The messages "Weak convergence" or "No convergence" may also be returned by the search algorithm. A run may also terminate with the message "Estimation failed! Algorithm returns NaN or +/- infinity". This typically indicates overflows in the floating-point calculations, e.g. dividing by zero or attempting to take the logarithm of a negative number, probably due to inappropriate starting values. If this occurs, optimization is restarted automatically at the default parameter values. This will often clear a problem with bad starting values.

GRAPHICS FOR REGIME SWITCHING MODELS

19. For simple Markov and Hamilton switching models, the M-1 series of independent filter probabilities can be listed and/or plotted. These are the probabilities of the regime being occupied conditional on information to date t, as used to weight the likelihood terms in estimation. In the case of Hamilton's model, these are summed over lags (p) to reduce M^(p+1) series down to M.

20. For the explained switching model, the M-1 series of variable switching probabilities are also plotted. When regime dummies have been specified there are up to M-1 different series for each regime, although differing only by the same offset at each t. These are averaged to create the series

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plotted.

21. For the smooth transition model, the regime weights are plotted (logistic functions of the transition indicator).

BOOTSTRAP AND SUBSAMPLING P-VALUES

22. Resampling computing p-values for tests by tabulating the statistics for a "pseudo-true" model, where the statistics are centred using the relevant components from the sample counterparts. This method can be used for t-ratios and Wald tests, and also M and CM tests. It is not so easily implemented for LM tests, although diagnostic tests for i.i.d. residuals are valid by construction in the bootstrap context. Other LM tests, and other tests are given their conventional asymptotic p-values. Note that resampling p-values are always indicated with a '*'.

23. Resampling p-values are computed for the Jarque-Bera test only for the bootstrap using Gaussian shocks. Otherwise the hypothesis is true by construction, so the bootstrap p-values are uninformative.

24. The cointegration tests (ADF and Phillips-Perron) cannot be resampled since there is no way to set up a pseudo-true version of the null hypothesis. Note that in single-equation regression models, the regressors (except lagged dependent variables) are held fixed in repeated samples. In cointegration models this is an unrealistic assumption even in large samples. It is better to consider a multi-equation model in which the unit root processes are generated endogenously. Monte Carlo experiments can be used to evaluate inference procedures in this case.

11 Directories and Files

DIRECTORIES (Windows folders):

Start-in — Must be specified by the operating system when TSM4 starts. This is usually set by the short-cut used to start the program, Options are presented by the installation program, or it can be set manually by editing the short cut. Otherwise, by default it is the directory where the Ox file used to start the program resides.

Notes:

1. On networks or shared systems, the user must have write permissions in the Start-in directory. Write permissions in the TSM Home directory ([ox-home]/packages/tsmod4/) are not required. It is NOT recommended to designate TSM-Home as the Start-in directory.
2. In the Windows installation of TSM, double-clicking on a .tsm file in Windows Explorer starts the program with the settings in question. The Start-in directory is one where the .tsm file resides. If the file is selected from a Start Menu the Start-in is the user's registered home directory.

Results — Selected by the user as an alternate location for program outputs. By default, it is the same as the Start-in directory. Reset it by the

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command File / Results / New Results File ... (navigate using file dialog) or the command File / Results / Locate Results Folder. (type path in the text field).

FILES

These files may be created by TSM4 in either the Start-in or Results directory. (S) indicates that a file can only reside in the Start-in directory. Otherwise, it will be created in the Results directory if that is different. (C) indicates that these file names can optionally be changed for a particular installation, by editing the file tsmgui4.h.

settings.tsm (S,C)	Contains all the user's settings and specifications, including the most recent estimates, and stored model specifications. Saved automatically before estimation or simulation runs, and at closedown.
registration.txt	Contains the user's licence code. By default, this is written to the TSM Home directory, subject to the user having write permissions, and there being no pre-existing licence file there. Otherwise, it is written to Start-in directory or, if this also contains a licence file, to the current results folder. This allows multiple licenced users to share the same installation. NOTE. The program looks for registration.txt in reverse order, first looking in current Results directory, then in Start-in if this is different, and finally in TSM Home. The 'registered user' for the current run is therefore the user who starts the program.
tsmod_run.ox (S,C)	User-editable Ox file, used to start the program incorporating the user's own code. The program can be started by running this file in OxEdit. (See Appendix A on changing module settings.)
usercode.ox (S,C)	This is the standard container for user's Ox code, although it is often convenient to have it contain just #include "..." compiler directives referring to files of code supplied by the user.
errchk (S)	Written by TSM4 at startup and deleted at closedown. Used to signal an error termination.

FILE TYPES

*.tsm	Named settings file with .tsm extension, same format as settings.tsm, saved by the user. Can be loaded manually to overwrite existing settings. When created using the File / Export... option, data and listings are bundled with the settings. The corresponding files are recreated automatically when the file is loaded, in this case.
*.txt	The program creates various files in standard text format,

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	including results files (images of the results window text) and settings files created with the Settings / Save Text... command. These files can be view and edited in Windows Notepad or other word-processing programs.
*.xls, *.csv	Microsoft Excel spreadsheet format is the default format for saving data sets, forecasts, and other listings. Other options available in the Options / Output and Retrieval dialog. *.csv files are text files, have the same capabilities as the Excel 2 spreadsheets created by Ox, and are widely portable.
*.tsd	Contain graphs and listings associated with the stored model having the same name as the file. These are loaded when the model is loaded. Their contents can typically be recreated by re-running estimations, and hence they are treated as temporary. They will be deleted when the model is deleted, and also at closedown, if the general option "Delete Temporary files on Exit" is checked.
*.ox	Text files containing Ox source code. They can be executable, such as tsmod_run.ox, but can also be included in other .ox files using the compiler directive ' #include "..." '. In normal use, a user's code files should be "#include"d in the standard code file usercode.ox. which is in turn #included in the executable tsmod_run.ox.
*.plt	Graphics file produded by Gnudraw, formatted for input to Gnuplot. These files are deleted by default after Gnuplot has processed them, but are optionally saved in the Results directory for further processing by the user. They are ordinary text files and can be viewed and edited in Notepad, OxEdit and similar programs.
*.png	The default bitmap graphics format. This format is read by a wide range of commercial graphing and word processing software, and converted to formats such as bitmap, Jpeg, Tiff, etc.
*.eps	Default vector graphics format. Can be read by various public domain software, and converted to .wmf, .emf and other formats by most graphics packages. Can also be inserted in Microsoft Word documents.

TSM saves data and graphics in a variety of other optional formats. See 2.2 File / Data..., 8.1 Options / Output and Retrieval and 8.5 Options / Graphics for details.

12. Hints and Tips

Here are some non-obvious pointers for getting the best results from the program.

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Suggestions from users for further tips are always welcome.

NUMERICAL OPTIMIZATION

1. TSM's optimization algorithm uses numerical derivatives, which under certain circumstances can give rise to problems with successful convergence. Its success can greatly depend on the good choice of starting values. Analytic derivatives, while more reliable, would be difficult to implement for the wide range of nonlinear models offered by the program. Some packages implement elaborate schemes to choose starting values automatically for specific models, such as ARIMAs, but again, this type of strategy is difficult to combine with a wide range of models. TSM implements a number of basic strategies, but these cannot entirely replace the user's initiative in exploring the parameter space to achieve successful optimization.

2. The program makes a maximum of two attempts to perform an optimization, where the second attempt uses the default starting values. If both attempts fail, there are several program settings that may assist.

   * Enable the parameter rescaling option in Options / Optimization and Run... Set the value to unity to limit the ratio of largest to smallest parameters (effective only if starting values are a guide to the relative magnitudes). Setting to a higher value (e.g.10) inflates all parameter values, to reduce the risk of rounding error in the evaluation of numerical derivatives.

   * Tinker with the simulated annealing settings in Options / Optimization and Run... There are not many useful guidelines for good choices here; in most cases raising the number of iterations cannot hurt, but also try switching it off (see Note 8 below).

   * The scaling of the variance/intercept parameter in GARCH models can be critical, especially in the IGARCH case. See Options / ML and GARCH... for details.

   * Experiment with the settings for EGARCH and GARCH-M models in Options / ML and Dynamics...

   * For dynamic parameters (AR, MA etc.) experiment with the bounding option in Options / Optimization and Run...

3. None of these fixes is guaranteed to improve matters, but setting starting values to good guesses of the estimates is always helpful. For example, if it is believed that a unit root exists in ARMA (or GARCH) models, start the AR parameter at 1, rather than 0. Using the "Impose Unit Root" option in Model / Dynamic Equation may help similarly.

4. Another good strategy with a complicated model is to simplify it initially, by deleting or fixing some components. Estimate the simple model, then add back the deleted components one at a time. The estimates of the simpler model often provide the best starting values for those parameters

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in the more general one. This 'stepwise' approach to the optimum is often successful when an attempt to optimize the full model from the default initial values ends in failure.

5. As a last resort, try keeping a parameter away from illegal values by imposing inequality constraints. Set them in Values / ... after checking the checkbox for Parameter Bounds.

6. The estimation output can be optionally printed in the event of non-convergence, but note the caution given on the Options / Optimization and Run... help page, regarding the interpretation of these reported values.

7. Switching regime models (Markov switching and smooth transition models) often exhibit multiple maxima of the likelihood. Good starting values, and careful experimentation with different starting values, are strongly recommended. As a switching probability tends to 0 or 1, the likelihood becomes flat due to the logistic mapping employed, and the algorithm can get stuck at these points. Restarting with "plausible" probability values (such as 0.9, 0.1) often succeeds in this situation.

8. The simulated annealing algorithm uses randomization to decide on successive steps. With a multi-modal criterion function it is possible, if rare, for successive runs of the search algorithm to converge to different points. Running SA for a limited number of steps before starting BFGS also has the effect of randomizing the BFGS starting value. Repeating a run, from different starting points or with different algorithm settings, is always a good idea. While a preliminary SA search is the default setting, it may be preferable to have SA switched off as the default, and enable it only when needed. This will certainly speed things up.

CHOICE OF SYSTEM ESTIMATORS

9. Don't overlook the distinction between the Linear Regression and Dynamic Equation options. The latter always uses numerical optimization to compute the estimator, even when a closed-form solution exists. Large unrestricted VARs may be computed in the Linear Regression dialog using SUR. Exclusion restrictions can be imposed by "fixing" parameters, although they can be tested only by Wald tests on the unrestricted model.

10. There are two ways to estimate a Gaussian linear equation system by maximum likelihood. Least generalized variance (LGV) optimizes the concentrated log-likelihood function (the log-determinant of the covariance matrix). The "Gaussian ML" option estimates the log-likelihood as a function of all parameters, including the variance matrix, and hence is much more computationally intensive than LGV. This method is only required for models with nonlinear features such as ARCH/GARCH or Markov switching.

USING THE RESULTS WINDOW AS A TEXT EDITOR

11. Text can be typed or pasted freely into the window. To paste from the clipboard, right-click in the text area and choose Paste. To save text in a file, first name the file with File / Results / New Results File. Then select

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the desired text with the mouse and give the command File / Results / Save Selected Text. Note that subsequent saves will be appended to the same file. To avoid this behaviour, give the New Results File command again to create or reinstate a results file.

ENTERING DATA BY HAND

12. Use one of the following methods to type data directly into the program,. The second method is recommended for entering several variables at once. Don't forget to save the data set afterwards, before doing anything else.

13. Use the Setup / Data Transformation and Editing dialog to create a new variable. If no data are currently loaded, give the command Re-Size Sample and enter the desired sample size, in which case a new variable Zeros is created automatically. Otherwise, give the command Make Zeros. Use Rename to change Zeros to the name of the new variable. Then choose Edit/List /Compare, select the first observation, and press Edit Observation. To enter successive observations, type the values into the edit field and press "OK", repeatedly.

14. Alternatively, type the data by observation, either into a text editor or into the results window as described in 11 above. The first line should contain two integers: the number of observations (= lines to follow the first) and the number of variables (= values on each line). Separate entries on a line with a space, and terminate each line with [Enter]. Save the file with extension .mat or .txt. Next, select either File / Data / Open or File / Data / Merge, as appropriate. The new variable(s) are named Var# by default, where # denotes the column number(s). Give new names using 'Rename', and optionally enter descriptions using 'Description' in the Setup / Data Transformation and Editing dialog. Before doing anything else, save the data in text or a spreadsheet format.

MAINTAINING AND EXPORTING PROGRAM SETTINGS

15. To save a model specification, including data file name, estimator, sample size, parameter values, test options, etc., open the Model Manager ('double-M' button) select 'Store Current Model' and supply a name (the current run number is the default). This facility allows you to work on different projects in parallel during a session. You may have a complex multi-equation model set up, and need to do some exploratory regressions or swap data sets. Saving the model allows you to reload the settings later with Actions / Load Model, and pick up where you left off. Your stored models are saved with the other settings in the settings.tsm file.

16. To keep a permanent copy of your favourite operational settings, save them in a backup file with a name such as "mydefaults.tsm". If you then need to change the settings for a particular run, they are easily restored by the command File / Settings / Open, and selecting the backup file. (Note that restoring settings does not reset the run ID counter.)

17. Named settings files are also useful in a teaching context. Students can be supplied with a ".tsm" file containing a desired set of defaults and also stored models for estimation or simulation exercises. The students can

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easily undo any changes they have made by reloading the defaults file.

18. By default, settings files are saved with local path information to locate data and listings files, which may make them unsuitable for transfer from one installation to another. Use the "Export" option in File / Settings / Save As... to omit this local information. The search path for all files will then be set to the "Start-in" directory when the settings file is loaded. For example, a class exercise with preset model specifications and data could be distributed by bundling all the relevant files for distribution (e.g. in a zip file) and arranging for them to be extracted to the Start-in directory of each target TSM installation.

19. To over-ride the default behaviour of setting the run ID number to zero in a new settings file, add the line
RUN_ID = ***;
to your text file of settings, before reloading them as described in Appendix E, where *** is your current ID value.

DOING SIMULATIONS

20. A star feature of the program is the ability to stochastically simulate any model that it can estimate, using either randomly resampled residuals or computer-generated shocks. The simulation module is the basis for nonlinear forecasting, bootstrap testing, and Monte Carlo experiments. To gain insight into the properties of an estimator, it is always a helpful exercise to apply it to artificial data from a known model.

21. To create an artificial sample, do the following
    1) Clear the data (File / Data / Clear).
    2) Set a sample size. In Setup / Data Transformation and Editing, choose Edit, scroll down to 'Re-Size Sample', enter a value, and press 'Go'. A variable called Zeros with the specified number of observations is automatically created.
    3) Open Options / Simulation and Resampling, and choose a shock distribution, either Gaussian or Model. In the first case, also set the shock variance. In the second case, a likelihood function must be specified in Model / Dynamic Equation.
    4) Set the model specifications in the usual way, selecting Zeros as the dependent variable. Pre-sample values are used to start a dynamic simulation and, if desired, these can be inserted in Zeros in Setup / Data Transformation and Editing.
    5) Enter parameter values in the relevant Values dialogs. (Don't forget variance parameters in the case of 'Model' shocks.)
    6) Open the Model Manager and save your specifications under a suitable name.
    7) Select Actions / Simulate Current Model, and add the artificial data to the data set if desired.
    8) Alternatively, use your model to set up a Monte Carlo experiment. Note how a different model can be used to estimate from the simulated data, to permit misspecification analysis.

22. Whilst the simulation code has been carefully checked, there are so many

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combinations of model features available that it is not possible to guarantee that they will all work together as intended. To ensure the integrity of simulation results, it is a good idea to run a check on the selected model. Users may also wish to check out their own supplied code.
To verify that a model is being correctly simulated, follow these steps:

1) Evaluate the model with a data set and chosen or estimated parameters, to generate a set of residuals.
2) Open Options / Simulation and Resampling, and select 'Bootstrap' for the Shock Distribution. In the box Random Number Seed, enter the value -1. This setting causes the simulation to be done with the actual residuals, without random resampling.
3) Run Actions / Simulate Current Model and save the simulation. This should match the original series exactly apart, conceivably, from small rounding errors. Compare the series in Setup / Data Transformation and Editing. Choose 'Mark' for one series, then 'List/Edit/Compare' for the other to see them side by side.
4) In a Markov switching model, the simulation involves random regime switches. To disable these, put the switching probabilities to 0 or 1 in the simulation. In the case of explained switching models, choose parameter values large enough to ensure that the switching probabilities are either 0 or 1 for nearly all values of the explaining variables.

Don't forget to reset the random number seed afterwards! Should a flaw in the simulation code be suspected, please notify the author.

STARTING TSM FROM WINDOWS EXPLORER

23. Double-clicking on a TSM settings file, with extension ".tsm" and red TSM icon has the same effect as starting the program from the Start menu and then loading the settings with the command "File / Settings / Open...". The "Start-in" directory is in this case the directory where the target TSM file resides.

24. Any data file having a supported format can be selected in Explorer and loaded into TSM. In this case, right-click the file with the mouse and select the option "Open with ..." from the context menu. Select the "Choose Program..." option, and choose "start_tsm" (with the Windows batch file icon) from the list.
If this option does not appear in the list, choose "Browse...", navigate to the TSM_HOME directory and select the file "start_tsm.bat" from the file list. It should only be necessary to do this once.
Notes:

1) If the option "Always use the selected program to open this kind of file" is checked, simply double-clicking on the file icon will in future load the file into TSM. Only choose this option if you don't edit this type of file in your spreadsheet program by default..

2) The directory containing the data file is used as the Start-in directory. If it contains a "settings.tsm" file, the settings are loaded from there. Otherwise, the defaults are set and a new "settings.tsm" is created.

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RUNNING SEVERAL INSTANCES OF TSM

25. To run lengthy optimizations or Monte Carlo runs, without tying up the program interface, try the option for exporting batch jobs to be run from the command line. For details, see BATCH JOBS under 6.1 Actions / Run Estimation and RUNNING AN EXTERNAL PROCESS under 3.10 Setup / Monte Carlo Experiments. When these jobs terminate, their outputs are written to text files with the run number. Give the command File / Load Text File to write the contents to the results window in the usual way.

26 By default, a batch job is launched automatically to run concurrently with the GUI. This is the efficient way to make use of a dual core processor, since TSM is not multi-threaded even under Ox 5. Alternatively the run (or runs) can be postponed to a time when the machine is otherwise idle. In this case they must be launched manually, as regular Ox programs.

27. It is also possible to run two or more instances of the GUI concurrently. The only major problem to be avoided in this case is the different sessions interfering with each other, by attempting to access and write to the same files. The trick is to create a different working directory for each instance. In Windows, do as follows:
    * Use the ' File / Settings / Export ' command to bundle your data and models into a portable '.tsm' file.
    * Create a new directory for each instance, and copy the .tsm file to each.
    * Start each instance by double-clicking on the .tsm file (see 23 above).

    The directory containing the .tsm file becomes the Start-up directory for each instance, with data, graphics, '.tsd' (model) and results files all written there by default.

28. For a more permanent multi-tasking setup, create multiple Windows shortcuts on the Start Menu, each edited to point to a different 'Start-In' directory. Give these shortcuts suitable names to distinguish them.

29. Another use for multiple instances is where TSM is running the user's Ox code. The supplied Windows shortcut "TSM4 with User Code" provides an example. See Appendix C for further details.

TROUBLESHOOTING

30. If the program appears to behave unpredictably, this may be because a setting has been changed inadvertently. For example:
    * The values of certain estimated parameters (e.g. MA parameters, GARCH parameters can depend on program settings.
    * If a parameter is "fixed" at zero in the Values dialog, no value is reported for it in the output. It might appear that the estimated specification is different from the chosen one. (Note that when variable(s) are fixed, the relevant Values button is highlighted and menu item(s) checked, as a reminder.
    * Corruption of the settings file (which is reloaded at start-up unless renewed) can occasionally occur.

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If you cannot figure out what the problem is, reset the program to defaults with File / Settings / New. Alternatively, close the program, delete the "settings.tsm" file, and restart.

31. Another option is to write the current settings to a text file (File / Settings / Save Text...) and inspect this output. Note that only non-default settings are listed. The usage of variable names can be checked in the programming manual.

32. If the program attempts to execute an illegal Ox instruction and crashes, a message is displayed, and then it automatically restarts. The Ox error message appears in the console window (second TSM icon on the taskbar) and can be copied to the clipboard and saved (follow the onscreen instructions). This message can guide users in debugging supplied code. If the error is due to a TSM bug, please send in the error message as requested!

33. The error recovery screen displays options for quitting, continuing, and exporting the current settings to a file. This file contains valuable diagnostic information, preserving the last recorded state of the program before the crash. If possible, please send in this file along with the error message.

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